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MTR-597

BR-90 ASSEMBLY PROGRAM - BRASS

JUNE 1968

J.A. Terrasi

and

J.C. Penney

Prepared for

DIRECTORATE OF PLANNING AND TECHNOLOGY
ELECTRONIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
L. G. Hanscom Field, Bedford, Massachusetts

Project 512V
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FOREWORD

The work reported in this document was performed by The MITRE Corporation, Bedford, Massachusetts, for the Directorate of Planning and Technology, Electronic Systems Division, of the Air Force Systems Command under Contract AF 19(628)-5165.

REVIEW AND APPROVAL

This technical report has been reviewed and is approved.

WILLIAM F. HEISLER, COL, USAF
Chief, Command Systems Division
Directorate of Planning & Technology

ABSTRACT

This document describes the features, user procedures, and program/coding specifications for the BR-90 Assembly Program (BRASS) which is operational on an IBM 1410 computer.

TABLE OF CONTENTS

SECTION I

BACKGROUND

BRASS, a BR-90 assembly program, was designed for use at the AFICCS Support Facility specifically to provide a vehicle for experimental program development under the Display Console Technology Task. Outstanding features of the assembler are the following: 1) tape (not disk) oriented; 2) AFICCS independent; and 3) operational on third-generation computer systems (emulation).

During the BRASS implementation phase, the standard BR-90 Normal Mode Control Program (N-mode) was used as part of the test package and the following highlights were noted: 1) N-mode consists of 4000 source statements with 800 user-labels; and 2) BRASS assembled N-mode in 12 minutes using 1/5 of the allowable user-label area for N-mode labels.

SECTION II

USER PROCEDURES

2.0 INTRODUCTION

BRASS, the BR-90 (AN/FYQ-45) Assembly Program, is an IBM 1410 program which assembles BR-90 source statements into BR-90 executable code. Input is fixed format, one card per source statement; output is to cards, each card containing a maximum of 34 BR-90 words (in BCD format). The assembly is a two-pass operation using tape as intermediate storage.

2.1 INPUT CARD FORMATS

A BRASS input deck is defined as a TITLE card followed by one or more instruction and/or comment cards terminated by an END card.

2.1.1 TITLE CARD

The TITLE card, the mandatory first card in the deck, has the following format:

Columns	1-6:	program identity
	7-11:	TITLE
	29-78:	remarks

where program identity is an optional 1 through 6 character identification.

Program identity and remarks will be printed in the header line of each page of the assembly listing. In addition, the program identity will be punched in columns 75 through 80 of each object card.

2.1.2 INSTRUCTION CARD

Each instruction card has the following format:

Columns	1-6:	label
	7-10:	operation code
	11-12:	address option
	14-28:	operand/operand address
	29-80:	comments

2.1.3 LABEL

A label consists from 1 to 6 characters left-justified in the label field. At least one character of the label must be

non-numeric and the label must not be defined more than once. Note that plus signs, minus signs, or commas should not be used in labels since these symbols are used within an expression as delimiters. Note also that an asterisk (*) should be avoided as the first label character since it would indicate a comment card.

2.1.4 OPERATION CODE

An operation code must be one of the 16 machine codes or one of the 12 psuedo-operations defined in Appendix A. The entry must be left-justified.

2.1.5 ADDRESS OPTION

For machine codes, an address option must be one of the 9 options listed in Appendix A. For psuedo-operations, the address option field must be blank.

2.1.6 OPERAND/OPERAND ADDRESS

The operand/operand address may be one of the following:

blank;
an octal number;
a decimal number;
a label; or
an expression, a combination of labels and/or decimal numbers.

The entry must be left-justified.

2.1.7 COMMENTS

This field is ignored by the assembler but is carried on the assembly listing.

2.2 COMMENT CARD

Each comment card has the following format:

Column 1: *
Columns 2-80: remarks

The comment card is ignored by the assembly processor, but is carried on the assembly listing.

2.3 END CARD

The END card has the following format:

columns 7-9: END
columns 14-28: location of first executable instruction.

Columns 14-28 may be blank or may contain a decimal number, a label, or an expression. A non-blank entry must be left-justified. If this field is blank, the location of the first executable instruction will be assumed to be the lower limit of BR-90 user core defined as 0062_8.

2.4 OBJECT DATA CARD

The Object Data Card has the following format:

columns 1-4: octal location of the first BR-90 word punched in the card.
columns 5-6: decimal number of BR-90 words punched in this card ($01 \leq COUNT \leq 34$).
columns 7-74: consecutive BR-90 words where a BR-90 word is represented by two BCD characters.
columns 75-80: program identity.

Object Data cards are filled with sequential BR-90 word representations. Any break in the sequential flow of the BR-90 source program will cause a new object data card to be generated. Thus, the object data cards are independent of one another, and the order of the object deck is not significant.

2.5 OBJECT END CARD

The Object End card has the following format:

columns 1-3: END.
columns 4-7: octal location of the first executable instruction of the BR-90 program.
columns 75-80: program identity

2.6 ASSEMBLER ERROR INDICATORS

A source statement may generate one or more assembly errors. These error conditions are noted by character error flag codes carried on the assembly listing to the right of the source statement image. These error flags and their associated meanings are as follows:

Error Flag	Meaning
U	Illegal label field
M	Multiple-defined label
A	Illegal operation and/or address option field
O	Illegal operand/operand address field
L	Location counter overflow ($>7777_8$)

Error types U, M, A, and O will cause a BR-90 "all zeros" word to be generated. Error type L is only a warning indication noting that overflow has occurred and that the location counter was reset to 0062_8 at the first instance of overflow.

2.7 OPERATING PROCEDURES

BRASS, a non-AFICCS dependent program, may be called by one of two methods:

a) by COPS within AFICCS, if SAP assembled the BRASS AUTOCODER source statements; or

b) by an object deck loader, if PR108 assembled the BRASS AUTOCODER source statements.

BRASS non-AFICCS hardware requirements are as follows:

a) minimum of 20K 1410 core;

b) one tape drive;

c) card reader/punch;

d) console typewriter; and

e) printer.

To assemble BR-90 source programs using BRASS:

a) mount a blank tape on channel 1, drive 2;

b) ready card punch;

c) if in AFICCS, load BR-90 source program deck(s) in reader and call BRASS via console typewriter.

   If non-AFICCS, load object deck loader, BRASS object deck, and BR-90 source program deck(s) in reader, and bootstrap the loader.

d) enter date of BR-90 assembly after typewriter cue message;

e) upon completion of the assembly process, AFICCS may be reloaded by placing the AFICCS system tape on channel 1, drive 1 and pressing COMPUTER RESET and START.

BRASS accepts batch assemblies. If no END card is used, the assembler generates an object end card and a dummy "end card" printer line with the "A" flag set.

APPENDIX A

LEGAL VALUES

OPERATIONS

The following are the legal operations and their associated meanings.

MNEMONIC	OPERATION
BU	Branch unconditional
ST	Store X-register
XF	External function
IO	Input/output
BV	Branch on overflow
LD	Load X-register
DS	Display
XM	Extract to memory
BL	Branch link
EX	Extract to X
AD	Add to X
SU	Subtract from X
BZ	Branch on X equal to zero
MG	Merge to X
SH	Shift X right
MM	Merge to memory

ADDRESS OPTIONS

OPERATIONS

For legal operations, with the exception of the SH operation, the following are the legal address options and their associated meanings.

ADDRESS OPTION	DESCRIPTION
DS	Direct from scratchpad
IS	Indirect from scratchpad
DM	Direct from memory
IM	Indirect from memory
DR	Direct relative
IR	Indirect relative

For the SH operation, the following are the legal address options and their associate meanings.

ADDRESS OPTION	DESCRIPTION
OL	Open logical right shift
CL	Closed logical right shift
ON	Open numeric right shift

OPERAND/OPERAND ADDRESS

For legal operations, with the exception of the SH operation, the operand/operand address must be either blank or an EXPRESSION depending upon the address option selected.

For address options DM or IM, the operand/operand address must be blank.

For address options DS or IS, the operand/operand address must be an EXPRESSION whose octal value is in the range 0 through 77.

For address options DR or IR, the operand/operand address must be an EXPRESSION whose value is within 77_8 positions of the location of the instruction; that is, the value [EXPRESSION −1 - location of the instruction] must be between 0 through 77_8. This value is a relative address modifier and is placed in the actual machine instruction.

For the SH operation, the operand/operand address must be an unsigned decimal number whose range is 1 through 15.

An EXPRESSION is defined as a combination of labels and decimal numbers. If S means label and I means a decimal number, the following are legal EXPRESSIONS.

I

±I

S

±S

I±S

S±I

±I±S

±S±I

±S±S

±I±I

PSEUDO OPERATIONS

The following are the legal pseudo operations and their associated meanings. Appendix B contains more detail on the pseudo operations.

MNEMORIC	PSEUDO OPERATION
ORG	Origin
RES	Reserve
PZE	Plus Zero
Blank Field	Same as PZE
OCT	Octal
EQU	Equals
EQUB	Equals octal
VCO	Vector coordinates
SCO	Symbol coordinates
CIR	Circle
BCIC	Binary coded information console
PAGE	Page eject

PREDEFINED LABELS

The assembler defines a number of labels prior to any assembly. These labels may be used by any source BR-90 program. The user should be aware of what labels are predefined since the error M will be set if a user attempts to define a predefined label in his program. The following are the predefined labels and their associated octal values.

LABEL	OCTAL VALUE
*	Current value of the location counter
**	0
$EOM	37
$STOP	0
$START	1
$P1	2
$P2	3
$P3	4
$P4	5
$P5	6
$P6	7
$I1	10
$I2	11
$I3	12
$I4	13
$I5	14
$I6	15
$I7	16
$I8	17

LABEL	OCTAL VALUE
$NIA	20
$LG	21
$LH	22
$T1	23
$T2	24
$T3	25
$T4	26
$T5	27
$T6	30
$T7	31
$T8	32
$T9	33
$T10	34
$T11	35
$T12	36
$T13	37
$T14	40
$T15	41
$T16	42
$T17	43
$T18	44
$T19	45
$T20	46
$T21	47
$T22	50
$T23	51
$T24	52
$T25	53
$T26	54
$T27	55

LABEL	OCTAL VALUE
$T28	56
$T29	57
$T30	60
$T31	61
$T32	62
$T33	63
$T34	64
$T35	65
$T36	66
$T37	67
$T38	70
$T39	71
$T40	72
$MTWO	73
$MONE	74
$TWO	75
$ONE	76
$ZERO	77
$POW	100
$INA	104
$INB	110
$DIS	114

APPENDIX B

PSEUDO OPERATIONS

ORIGIN – (ORG)

The ORG pseudo op causes the location counter to be set to the value given in the operand/operand address field. The operand/operand address field must contain an expression whose value is in the range 0_8 to 7777_8. Labels, if used in the expression, must be previously defined. ORG may not be a labelled statement.

RESERVE – (RES)

The RES pseudo op causes the assembler to reserve one or more consecutive BR-90 words within the object program commencing with the current value of the location counter. The operand/operand address field must contain an unsigned decimal number within the range 1 to 4095. RES may be labelled, in which case, the label refers to the first word of the block. A reserve statement resulting in a location counter overflow is considered illegal.

PLUS ZERO – (PZE)

The PZE pseudo op causes the assembler to reserve one BR-90 word whose value is equal to the octal value of the expression in the operand/operand address field. A symbol appearing in the expression need not be defined prior to the PZE statement. A blank operation field is equivalent to the PZE pseudo op. PZE may be a labelled statement.

OCTAL – (OCT)

The OCT pseudo op causes the assembler to reserve one BR-90 word whose value is equivalent to the signed or unsigned octal number in the operand/operand address field. The octal number must be between -7777_8 and $+7777_8$. OCT may be a labelled statement.

EQUALS – (EQU)

The EQUALS pseudo op causes the label in the label field to be equated to the octal value of the expression in the operand/operand address field. A symbol appearing in the expression must be defined prior to the EQU statement. EQU must be a labelled statement.

VECTOR COORDINATES – (VCO)

The VCO pseudo op causes the assembler to generate two BR-90 words containing the x,y coordinates as defined by the EXPRESSIONS in the operand/operand address field. The operand/operand address field may be one of two formats:

a) EXPRESSION, EXPRESSION;

b) EXPRESSION, EXPRESSION, COMBINATION where COMBINATION may be the letters U, B, W, E in any order. These letter codes mean the following:

U = generate vector;

B = blink vector;

W = wide vector;

E = end of string.

A label in an EXPRESSION need not be defined prior to the VCO pseudo op. VCO may be a labelled statement.

SYMBOL COORDINATES – (SCO)

The SCO pseudo op causes the assembler to generate two BR-90 words containing the x,y coordinates as defined by the EXPRESSIONS in the operand/operand address field. The format of the operand/operand address field is EXPRESSION, EXPRESSION. A label in an EXPRESSION need not be defined prior to the SCO pseudo op. SCO may be a labelled statement.

CIRCLE – (CIR)

The CIR pseudo op causes the assembler to generate one BR-90 word containing information necessary to generate a circle. The operand/operand address field may be one of two formats:

a) EXPRESSION;

b) EXPRESSION, COMBINATION

where COMBINATION may be the letters W, B, N in any order. The meaning of these letter codes is as follows:

W = wide circle,

B = blink circle;

N = blank display.

A label in the EXPRESSION need not be defined prior to the CIR pseudo op. CIR may be a labelled statement.

BINARY CODED INFORMATION CONSOLE – (BCIC)

The BCIC pseudo op causes the assembler to generate a number of BR-90 words containing the character representations defined in the operand/operand address field. The operand/operand address field may have one of three formats:

a) XX...X$

1-14 characters

b) XX...X

15 characters

c) XX....X$COMBINATION

where $ is the string terminator and COMBINATION may be the letters E, B, L, M, N in any order. The meanings of the letter codes are as follows:

E = end of string;

B = blink symbol;

L = large symbol;

M = generate marker;

N = blank symbol.

BCIC may be a labelled statement, and if labelled, the label refers to the first BR-90 word generated.

PAGE EJECT – (PAGE)

The PAGE pseudo op directs the assembler to generate no BR-90 words, b t causes the printing portion of the assembler to start a new printed page. The PAGE pseudo op will be printed as the first line of the new page.

EQUALS OCTAL – (EQUB)

The EQUALS OCTAL pseudo op causes the label in the label field to be equated to the octal value of the signed or unsigned octal number in the operand/operand address field. The octal number must be between -7777_8 to $+7777_8$. The EQUB must be a labelled statement.

APPENDIX C

SAMPLE

BRASS ON-LINE RECORD OF RUN

```
R IDLOOP Ø2 IBM
I BRASS
R TYPE IN TODAYS DATE AS DD MMM YY
I 26 FEB 68
R END OF RUN--TO LOAD AFICCS PLACE BOOTSTRAP SYSTEM TAPE ON 1 AND COMPUTER RE
SET AND START

R IDLOOP Ø2 IBM
```

BRASS Source Code (80-80 List)

```
TEST1 TITLE                THIS IS AN EXAMPLE OF A BRASS ASSEMBLY
1LABELEQU    100           EQUATE                                    **
*                                        COMMENT CARD
2LABELEQU    1LABEL+10
*                                        COMMENT CARD
OCT77 EQUB   +77           EQUAL TO OCTAL
*                                        COMMENT CARD
      ORG    +512          ORIGIN
*                                        COMMENT CARD
      PZE    0             PLUS ZERO
*                                        COMMENT CARD
      ORG    *+10
      ST  DM                INSTRUCTION
*                                        COMMENT CARD
      PZE    $ONE          SYSTEM PRE-DEFINED LABEL
*                                        COMMENT CARD
      ST  DS $START
*                                        COMMENT CARD
      ST  OR *+45
*                                        COMMENT CARD
      RES    100           RESERVE
*                                        COMMENT CARD
             0             BLANK OPERATION=PZE
*                                        COMMENT CARD
MIN71 OCT    -71           OCTAL
*                                        COMMENT CARD
      VCO    OCT77+1,2,E   VECTOR COORDINATES
*                                        COMMENT CARD
      SCO    5,1+1LABEL    SYMBOL COORDINATES
*                                        COMMENT CARD
      CIR    15,W          CIRCLE
*                                        COMMENT CARD
      BCIC   TEST1.$EB     BINARY CODED INFORMATION CONSOLE
      PAGE
*
*      ERRORS
*
1LABELPZE    0             MULTI-DEFINED LABEL
99    PZE    0             ILLEGAL LABEL
      POZ    0             ILLEGAL OPERATION
      ST  DA 10            ILLEGAL ADDRESS MODIFIER
      PZE    +5000         ILLEGAL O/O ADDRESS
      ST  OR *+200
      OCT    1099
      ORG    A
      PZE    1LABEL+1+2
      ORG    4095
      PZE    $STOP         LEGAL INSTRUCTION, BUT OVERFLOW SET ON
      END    MIN77         START EXECUTING AT MIN77 LOCATION
```

APPENDIX C (Continued)

BRASS Assembly Listing

TEST1 THIS IS AN EXAMPLE OF A BRASS ASSEMBLY 26 FEB 68 PAGE 001

OCTAL LOC	OCTAL VALUE	LABEL	OP	ADD OPT	O/O ADDRESS	COMMENTS	ERROR
0144		1LABEL	EQU		100	EQUATE	**
		*				COMMENT CARD	
0156		2LABEL	EQU		1LABEL+10		
		*				COMMENT CARD	
0077		OCT77	EQUB		+77	EQUAL TO OCTAL	
		*				COMMENT CARD	
			ORG		+512	ORIGIN	
		*				COMMENT CARD	
1000	0000		PZE		0	PLUS ZERO	
		*				COMMENT CARD	
			ORG		*+10		
1013	0500		ST	DM		INSTRUCTION	
		*				COMMENT CARD	
1014	0076		PZE		$CNE	SYSTEM PRE-DEFINED LABEL	
		*				COMMENT CARD	
1015	0401		ST	DS	$START		
		*				COMMENT CARD	
1016	0554		ST	DR	*+45		
		*				COMMENT CARD	
1017			RES		100	RESERVE	
		*				COMMENT CARD	
1163	0000				0	BLANK OPERATION=PZE	
		*				COMMENT CARD	
1164	7707	MIN71	OCT		-71	OCTAL	
		*				COMMENT CARD	
1165	0400		VCO		OCT77+1,2,E	VECTOR COORDINATES	
1166	0011						
		*				COMMENT CARD	
1167	0026		SCO		5,1+1LABEL	SYMBOL COORDINATES	
1170	0624						
		*				COMMENT CARD	
1171	1710		CIR		15,W	CIRCLE	
		*				COMMENT CARD	
1172	2320		BCIC		TEST1.$EB	BINARY CODED INFORMATION CONSOLE	
1173	6520						
1174	2220						
1175	2320						
1176	0120						
1177	7321						

```
  O C T A L                    ADD
  LOC   VALUE   LABEL    OP    OPT    O/O ADDRESS                COMMENTS                          ERRCR

                         PAGE
                *
                *       ERRORS
                *
1200    0000    1LABEL   PZE           0                  MULTI-DEFINED LABEL                     M
1201    0000    99       PZE           0                  ILLEGAL LABEL                           U
1202    0000             POZ           0                  ILLEGAL OPERATION                        A
1203    0000             ST      DA    10                 ILLEGAL ADDRESS MODIFIER                 A
1204    0000             PZE           +5000              ILLEGAL O/O ADDRESS                       C
1205    0000             ST      DR    *+200                                                       C
1206    0000             OCT           1099                                                        C
                         ORG           A                                                           C
1207    0000             PZE           1LABEL+1+2                                                  C
                         ORG           4C95
7777    0000             PZE           $STOP              LEGAL INSTRUCTION, BUT OVERFLOW SET ON       L
                         END           MIN77              START EXECUTING AT MIN77 LOCATION            L
  00009 = NUMBER OF FATAL ASSEMBLY ERRORS
```

```
100001                                                          TEST1
1013055   415*                                                  TEST1
116321    74  9 W6U 8T E S T 1 ./                               TEST1
777701                                                          TEST1
END0062                                                         TEST1
```

SECTION III

PROGRAM/CODING SPECIFICATIONS

3.0 PROGRAM DESCRIPTION

The BRASS assembler was designed for use in the 1410 AFICCS system or on a 1410 computer which has no AFICCS system and has the following minimum hardware requirements:

20K core memory;

card reader/punch;

one channel, 1 tape drive;

printer; and

console typewriter.

To enable BRASS to maintain this duality, the following programming conventions were used:

a) origin at 500;

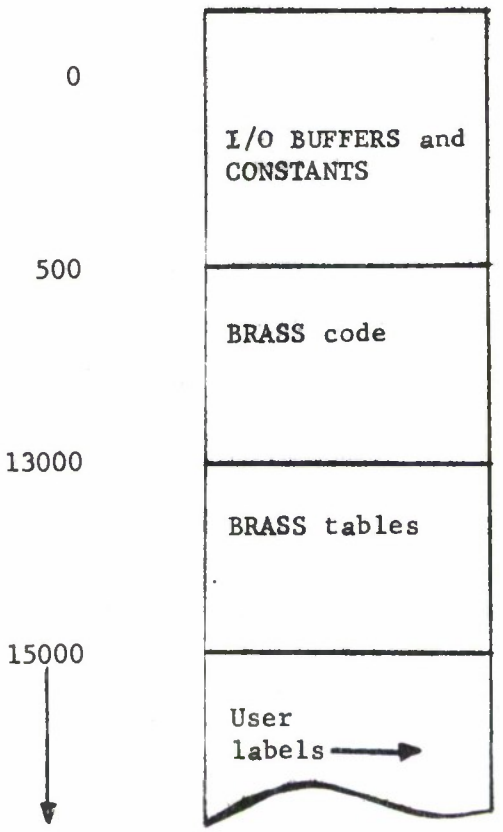
b) no pre-defined group mark - word marks; and

c) all I/O references imbedded within the program.

Because of these conventions, BRASS 1410 Autocoder source code may be assembled by either the SAP assembler or by the PR108 assembler. If assembled by SAP within AFICCS, BRASS will integrate on disk and will be assigned the COPS calling name BRASS. If assembled by PR108, a 1410 object deck will be punched which may be loaded into a 1410 computer by a standard bootstrap loader.

BRASS is a two-pass assembler. The first pass reads, partially assembles, and saves the BR-90 source code on tape. The second pass reads the stored instructions from tape and completes the assembly, prints the assembly listing and punches the BR-90 object card deck. BRASS has within it predefined system labels which may be used by any BR-90 source program.

BRASS's core map is as follows:



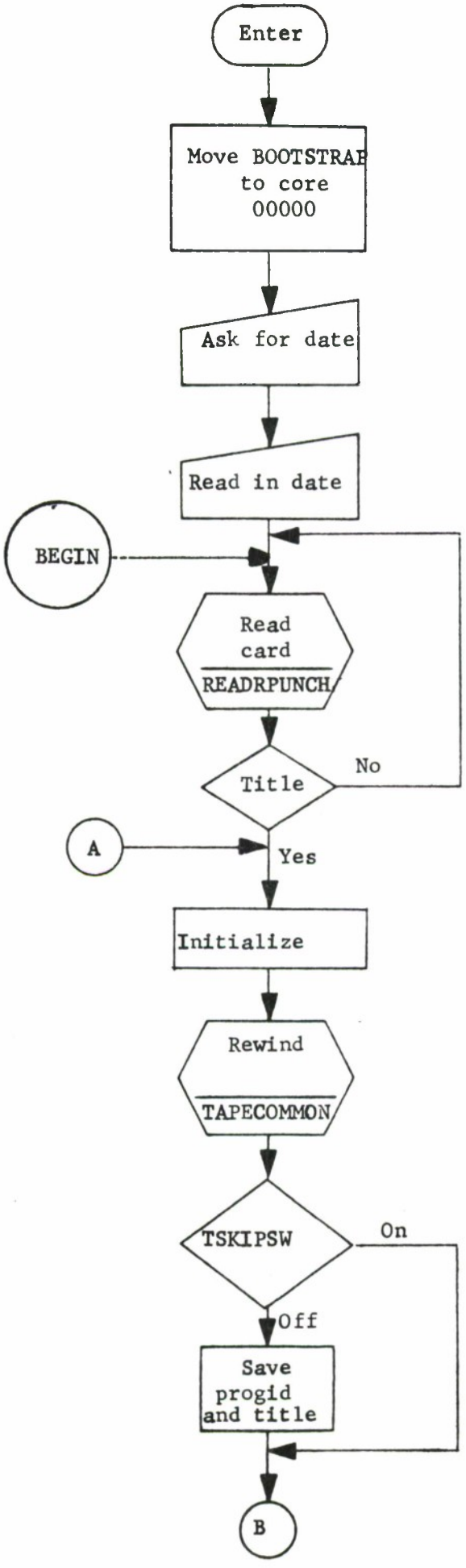
Lower core (0-499) is initialized immediately upon execution of the BRASS code. The user label table is built up from about 15000 and remains in core throughout the entire assembly process. Thus the limiting factor to the number of labels is the amount of core (up to 40K).

3.1 ROUTINE DESCRIPTION

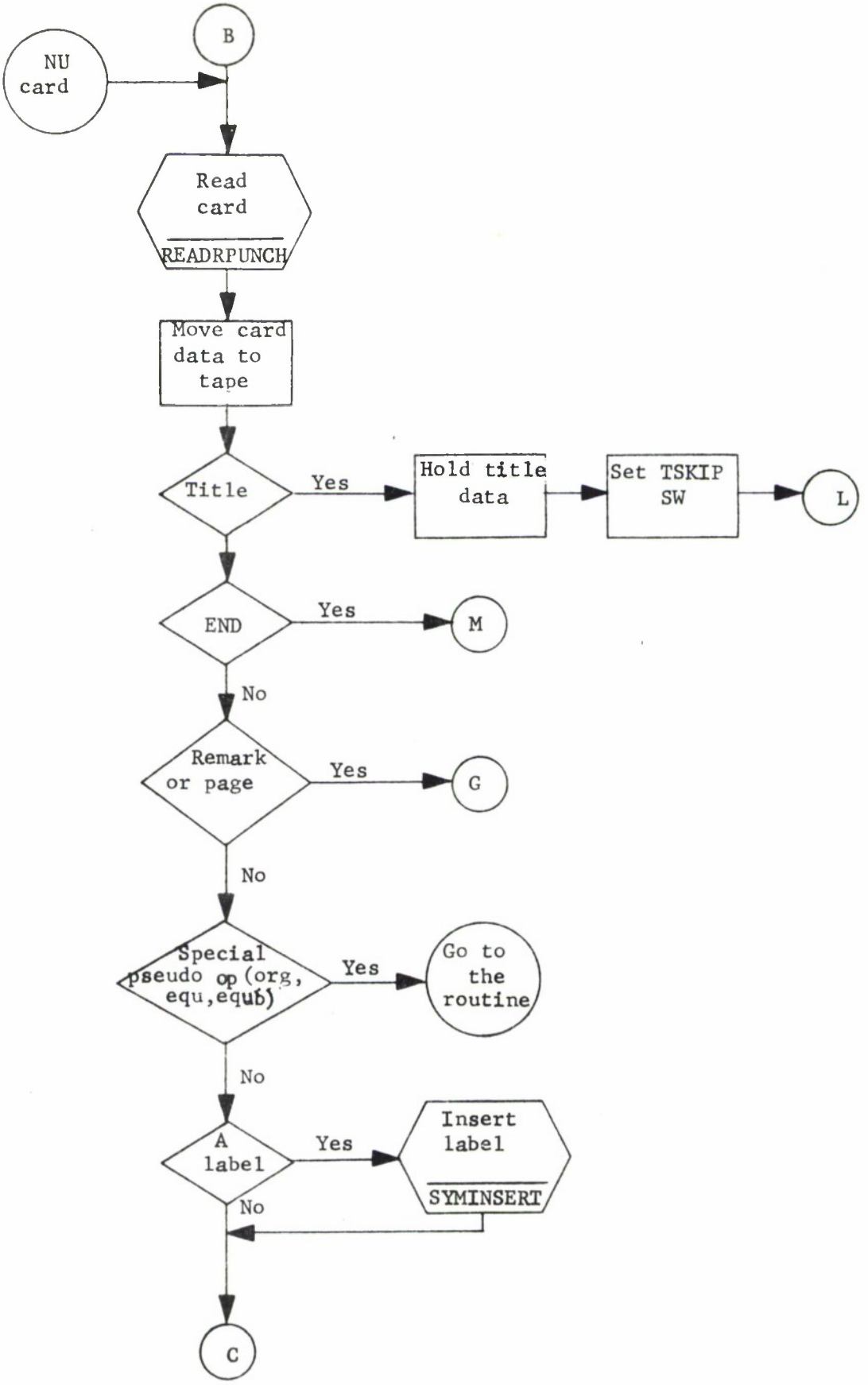
TITLE:	BR-90 Assembly Program (BRASS)
CLASS:	Program
SIZE:	15,000 characters
ORIGIN:	500
DATE:	27 February 1968
FUNCTION:	This program assembles BR-90 source code statements into executable BR-90 octal machine codes.
CALLING SEQUENCE:	Within AFICCS, type in BRASS. Otherwise, load BRASS 1410/PR108 object deck with 1410 object deck loader.
INPUT:	BR-90 source deck(s)
OUTPUT:	Assembly listing(s) and BR-90 object deck(s)
NORMAL RETURN:	At normal exit, BRASS types out cue message and halts. At such time, AFICCS may be reloaded by mounting the AFICCS system tape on channel 1, drive 1 and pressing COMPUTER RESET and START.
ERROR RETURN:	Program halts on unrecoverable errors.
ERROR PRINTOUTS:	Subroutines TAPECOMMON, READRPUNCH, and PRINTERR type out indicative hardware errors. "SYMBOL TABLE FULL - DUMP 40K CORE" - if assembly labels fill core from 15000 to 40000.
SUBROUTINES:	TAPECOMMON and READRPUNCH are explained in PCS-AF-1, Volume 2, Part 2. All other significant subroutines of BRASS are flow-charted in the following sections.
ACCESSED SDA's:	None.
REMARKS:	BRASS is programmed using 1410 Autocoder such that it could be assembled by either SAP or PR108. BRASS, therefore, is independent of AFICCS and may be used at a 1410 facility which has no AFICCS system.

3.2 FLOW CHARTS

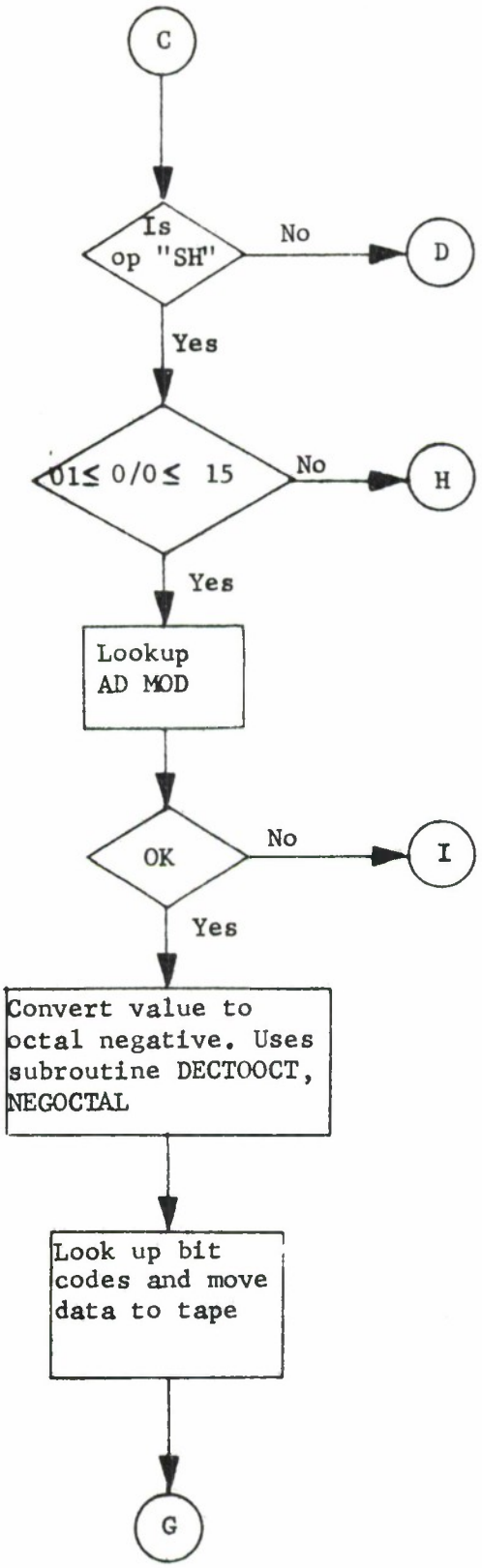
The following flow charts describe the program flow of the BRASS Assembly Program.



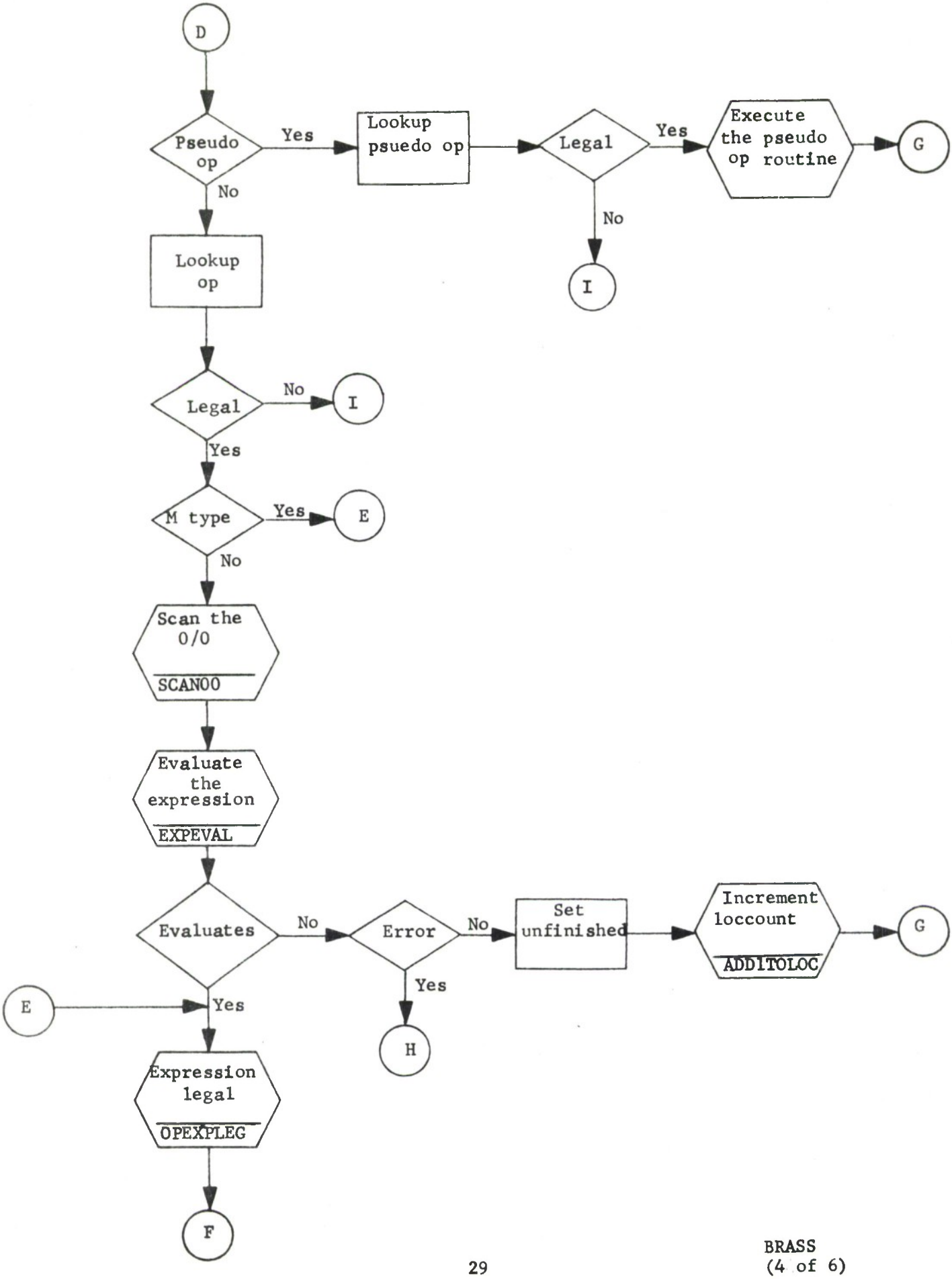
BRASS FLOW CHART
(1 of 6)


NU card
B
Read card
READRPUNCH
Move card data to tape
Title
Yes
Hold title data
Set TSKIP SW
L
END
Yes
M
No
Remark or page
Yes
G
No
Special pseudo op (org, equ, equb)
Yes
Go to the routine
No
A label
Yes
Insert label
SYMINSERT
No
C

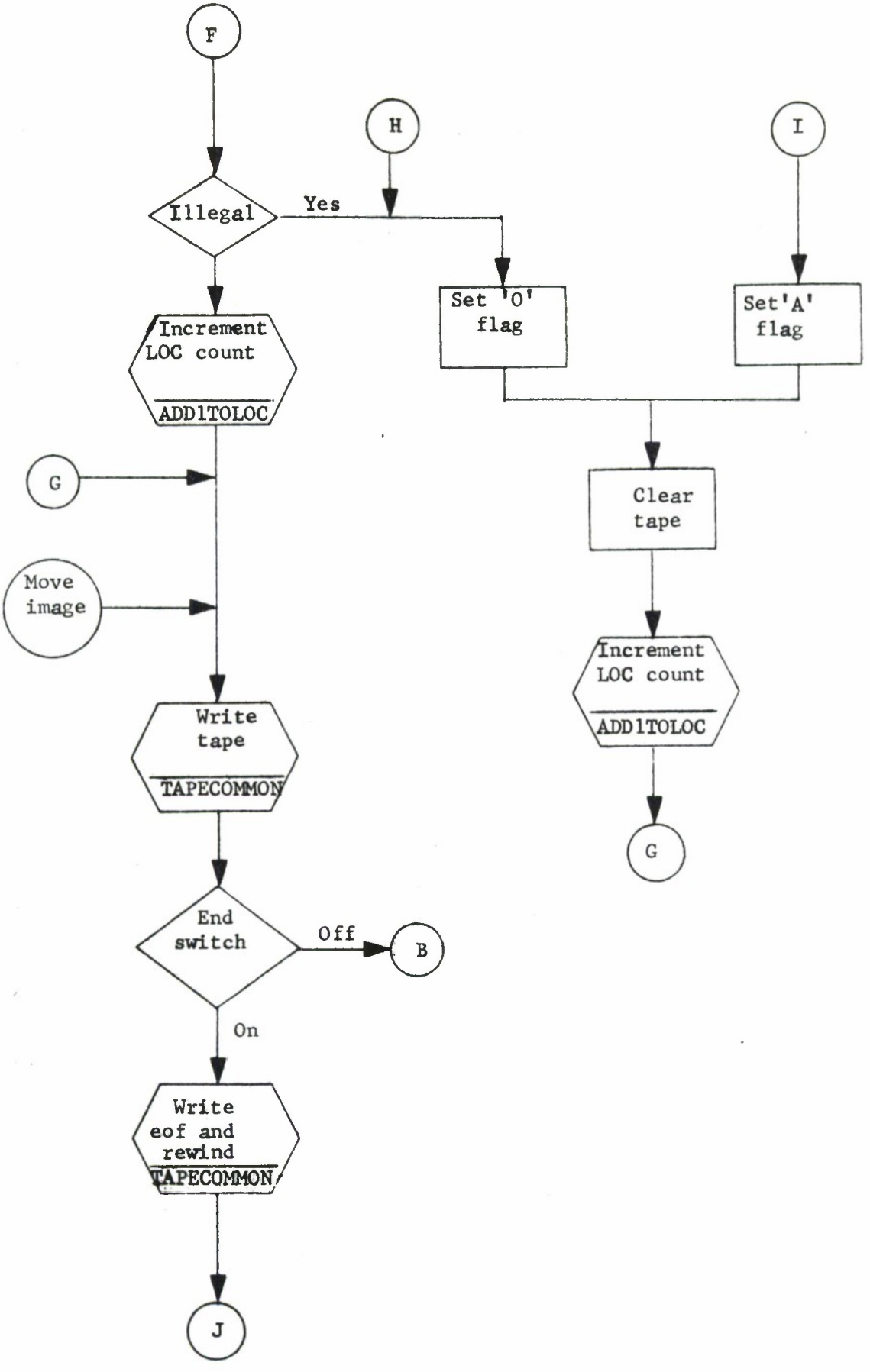
BRASS
(2 of 6)


C
Is op "SH"
No
D
Yes
01≤ 0/0≤ 15
No
H
Yes
Lookup AD MOD
OK
No
I
Yes
Convert value to octal negative. Uses subroutine DECTOOCT, NEGOCTAL
Look up bit codes and move data to tape
G

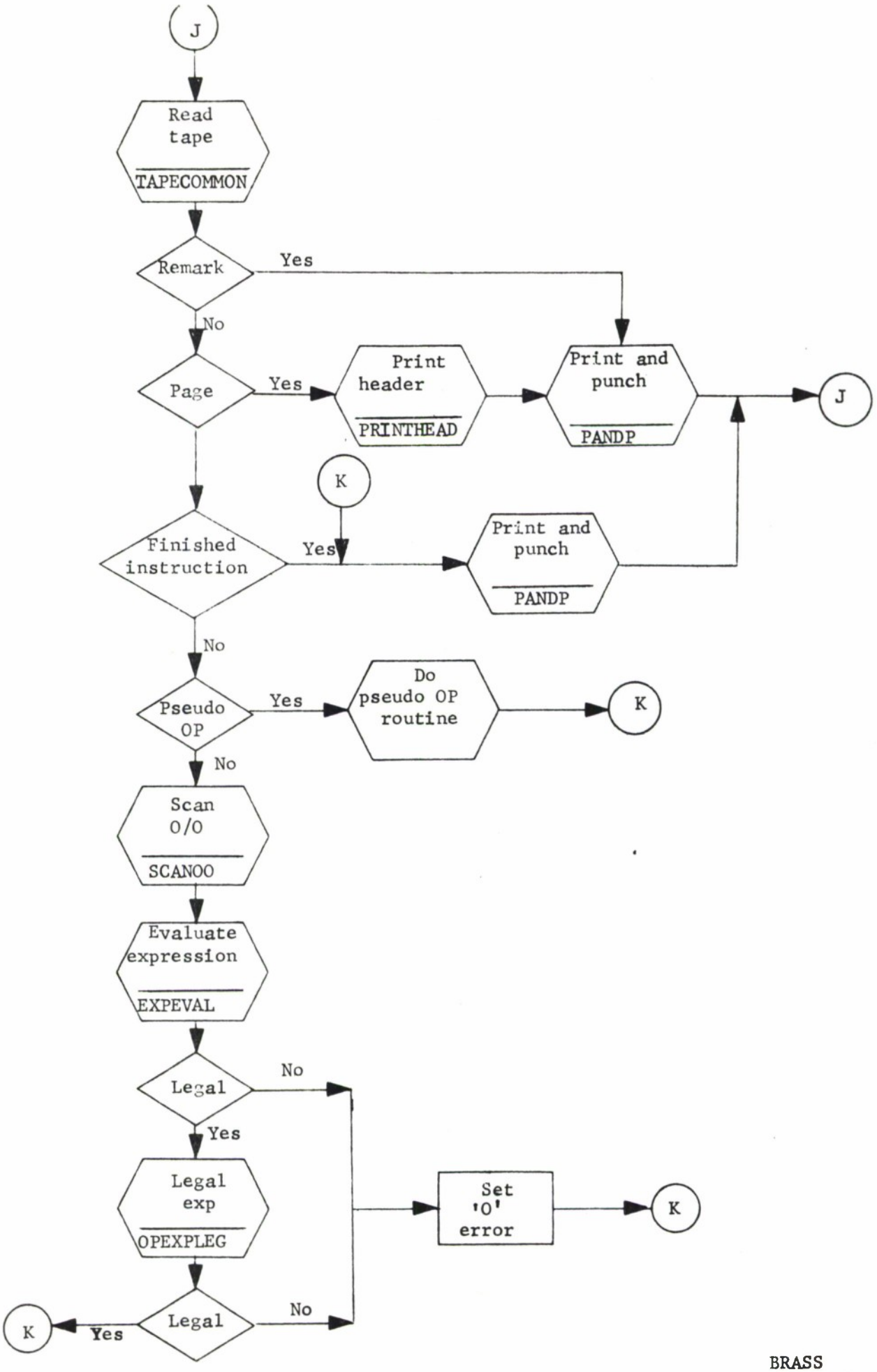
BRASS
(3 of 6)


D
Pseudo op
Yes
Lookup psuedo op
Legal
Yes
Execute the pseudo op routine
G
No
No
I
Lookup op
Legal
No
I
Yes
M type
Yes
E
No
Scan the 0/0
SCAN00
Evaluate the expression
EXPEVAL
Evaluates
No
Error
No
Set unfinished
Increment loccount
ADDITOLOC
G
Yes
E
Yes
H
Expression legal
OPEXPLEG
F

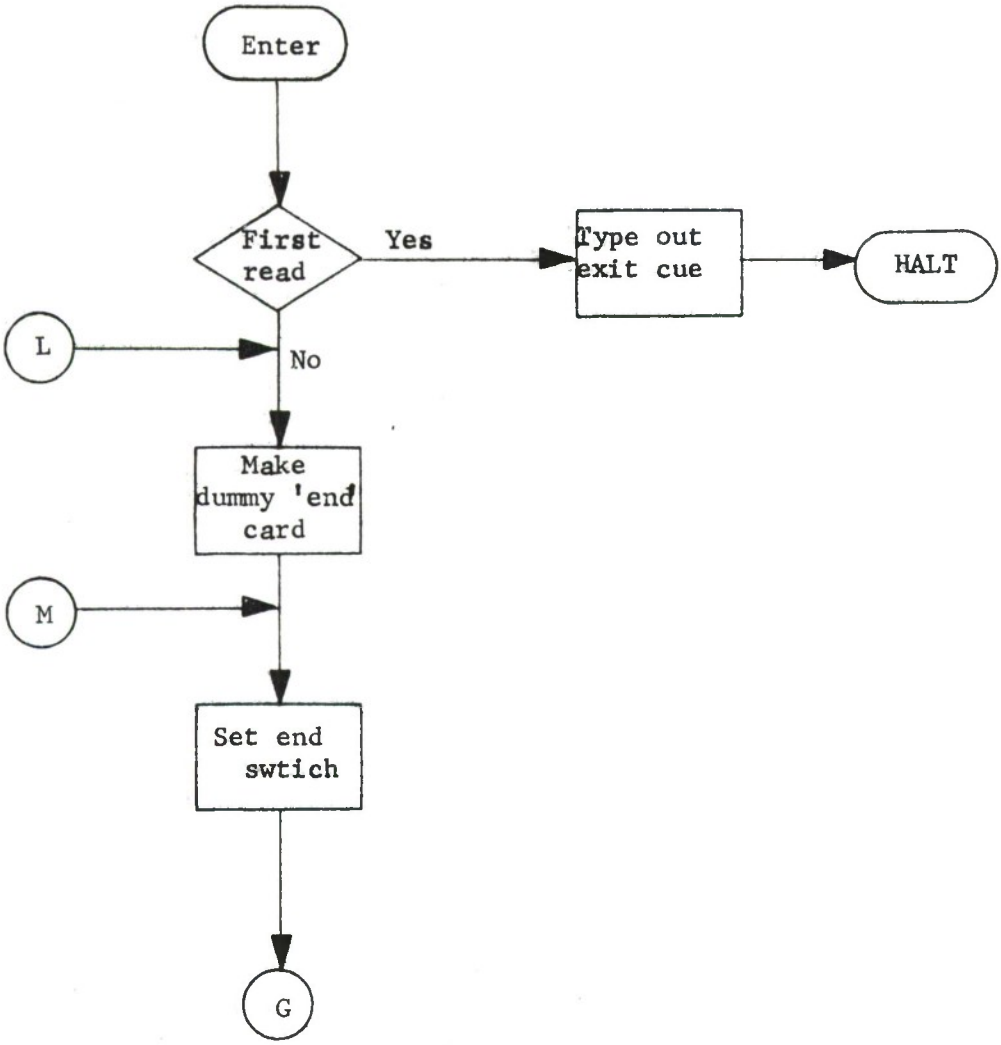
BRASS
(4 of 6)


F
H
I
Illegal
Yes
Set 'O' flag
Set 'A' flag
Increment LOC count
ADD1TOLOC
G
Clear tape
Move image
Increment LOC count
ADD1TOLOC
Write tape
TAPECOMMON
G
End switch
Off
B
On
Write eof and rewind
TAPECOMMON
J

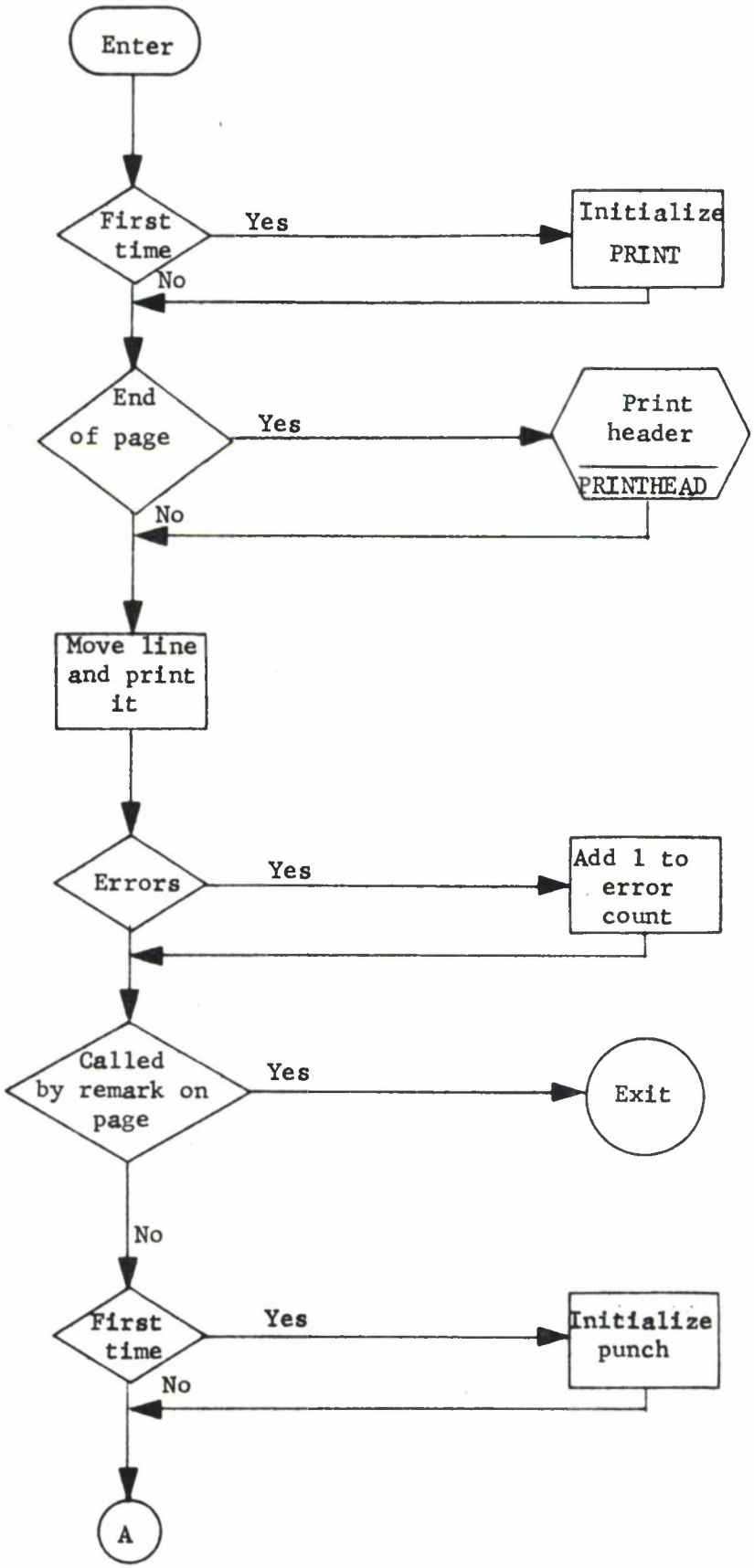
BRASS
(5 of 6)


J
Read tape
TAPECOMMON
Remark
Yes
No
Page
Yes
Print header
PRINTHEAD
Print and punch
PANDP
J
K
Finished instruction
Yes
Print and punch
PANDP
No
Pseudo OP
Yes
Do pseudo OP routine
K
No
Scan O/O
SCANOO
Evaluate expression
EXPEVAL
Legal
No
Yes
Legal exp
OPEXPLEG
Set '0' error
K
Legal
No
K
Yes

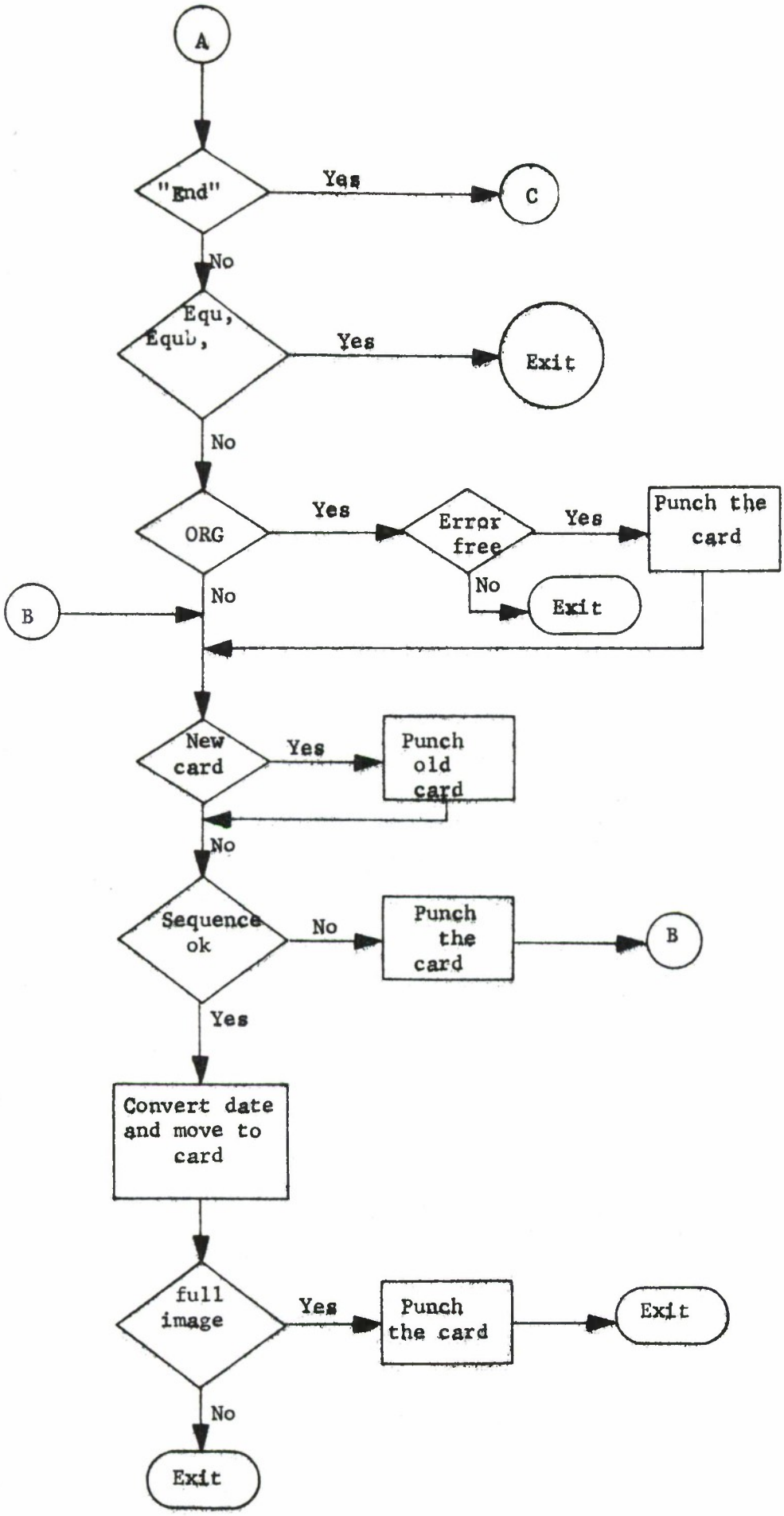
BRASS
(6 of 6)



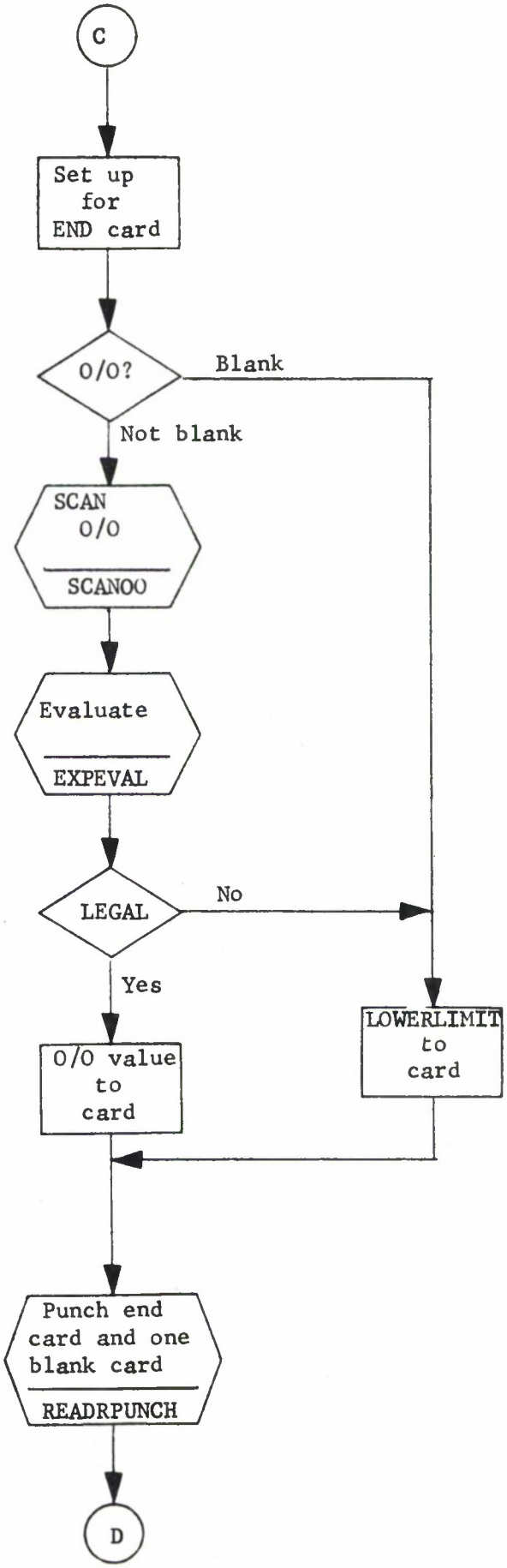
CARD END OF FILE FLOW CHART
(1 of 1)



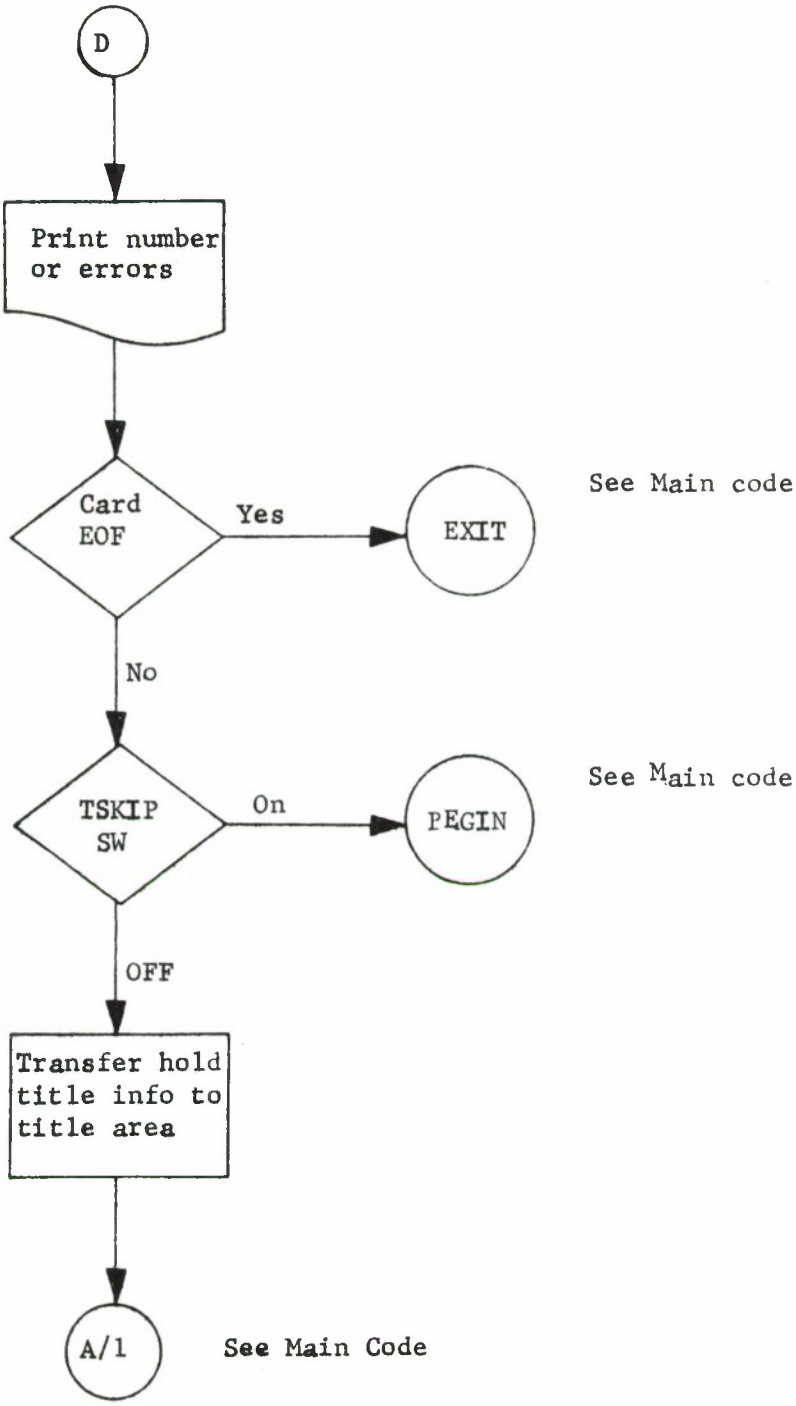
PANDP FLOW CHART
(1 of 4)


A
"End"
Yes
C
No
Equ,
Equb,
Yes
Exit
No
ORG
Yes
Error free
Yes
Punch the card
No
Exit
B
No
New card
Yes
Punch old card
No
Sequence ok
No
Punch the card
B
Yes
Convert date and move to card
full image
Yes
Punch the card
Exit
No
Exit

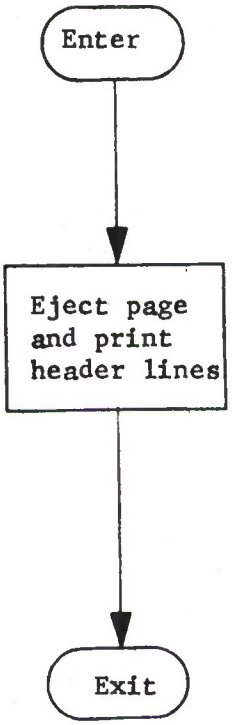
PANDP
(2 of 4)


C
Set up for END card
O/O?
Blank
Not blank
SCAN O/O
SCANOO
Evaluate
EXPEVAL
LEGAL
No
Yes
O/O value to card
LOWERLIMIT to card
Punch end card and one blank card
READRPUNCH
D

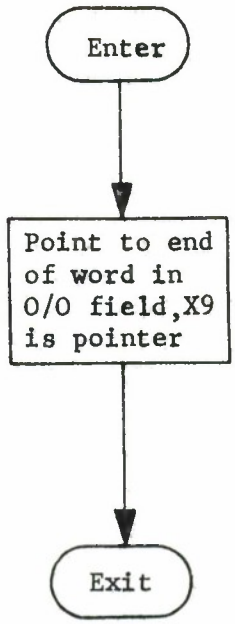
PANDP
(3 of 4)


D
Print number or errors
Card EOF
Yes
EXIT
See Main code
No
TSKIP SW
On
PEGIN
See Main code
OFF
Transfer hold title info to title area
A/1
See Main Code

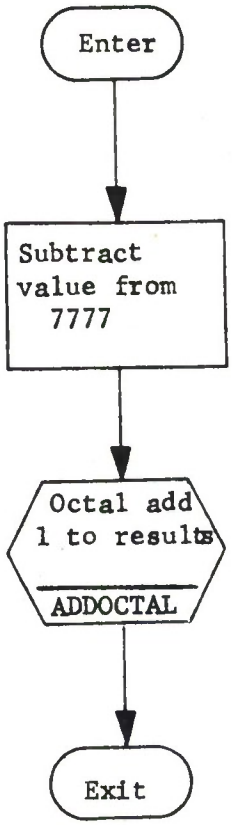
PRINTHEADER



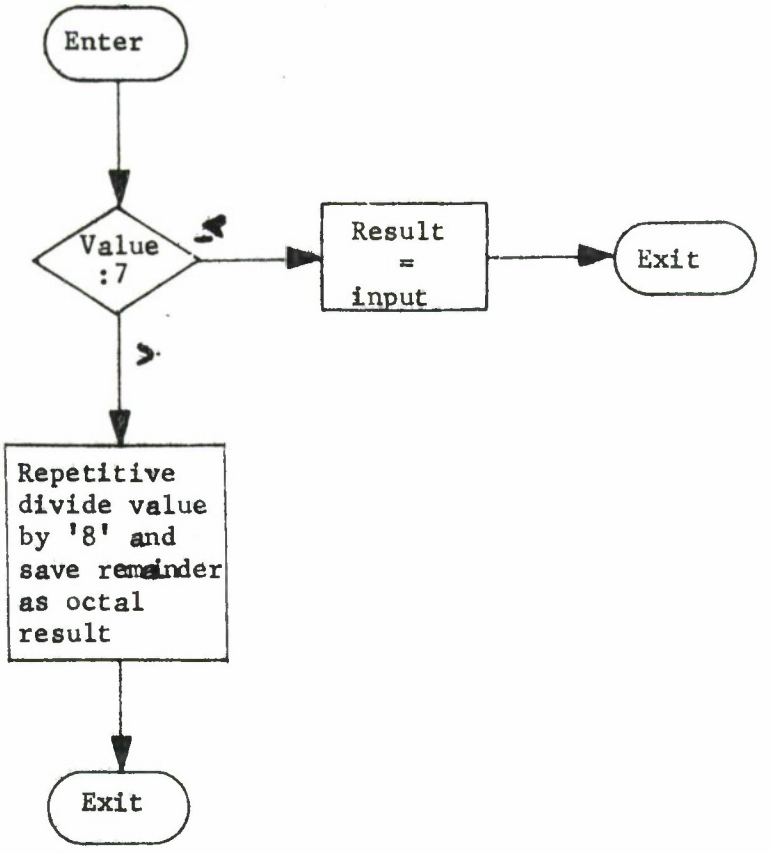
PRINTHEADER FLOW CHART
(1 of 1)



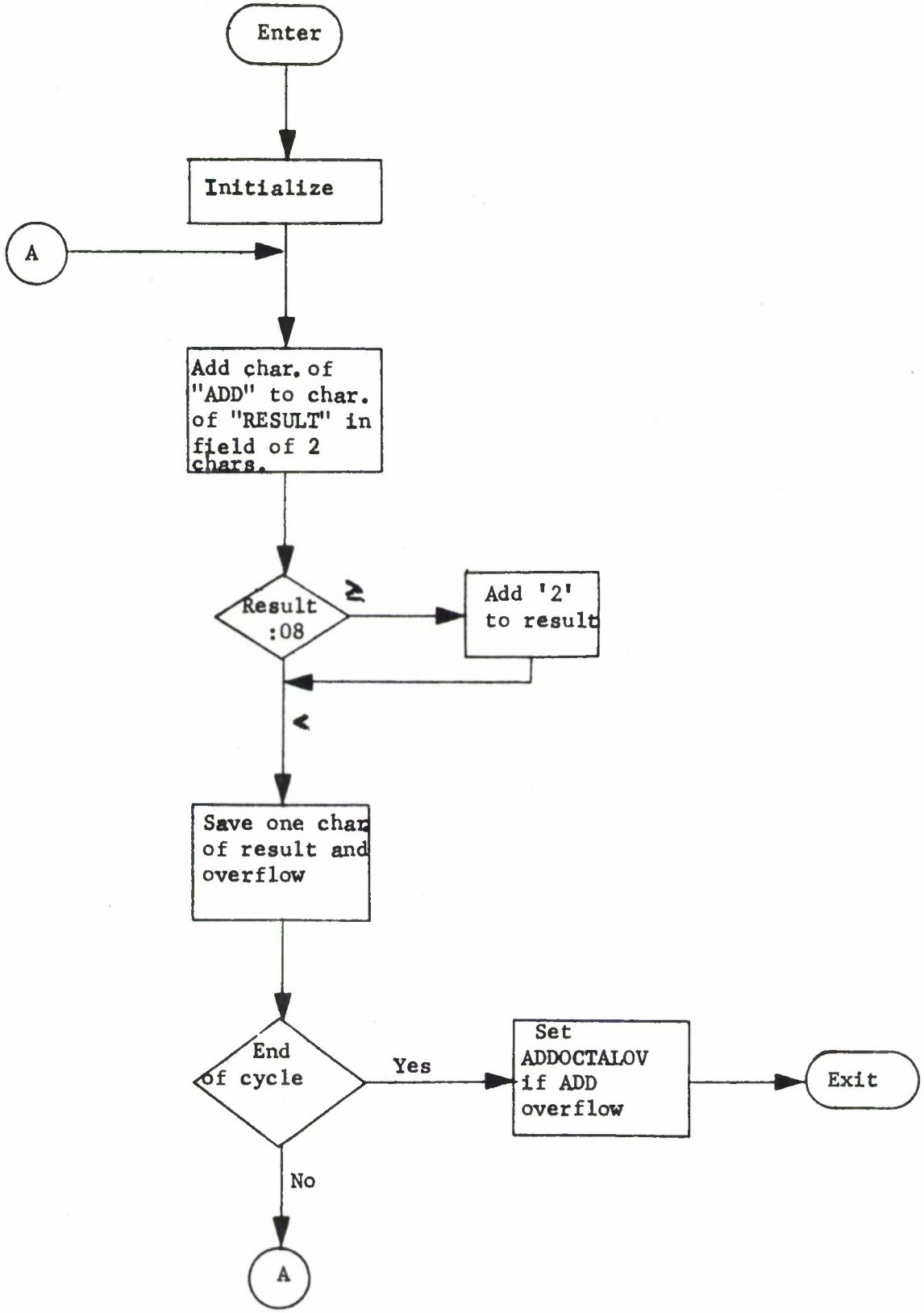
SCANOO FLOW CHART
(1 of 1)



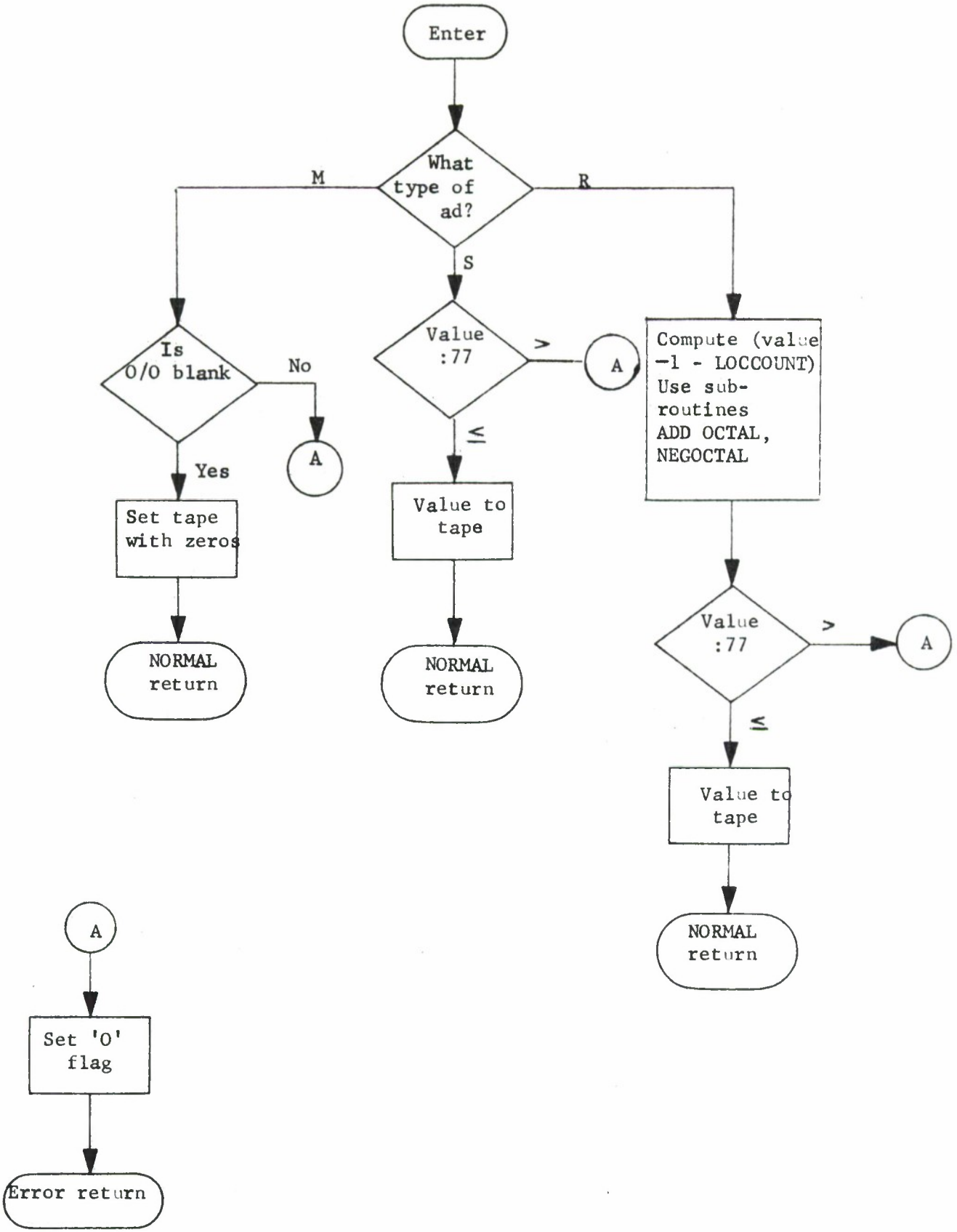
NEG OCTAL FLOW CHART
(1 of 1)



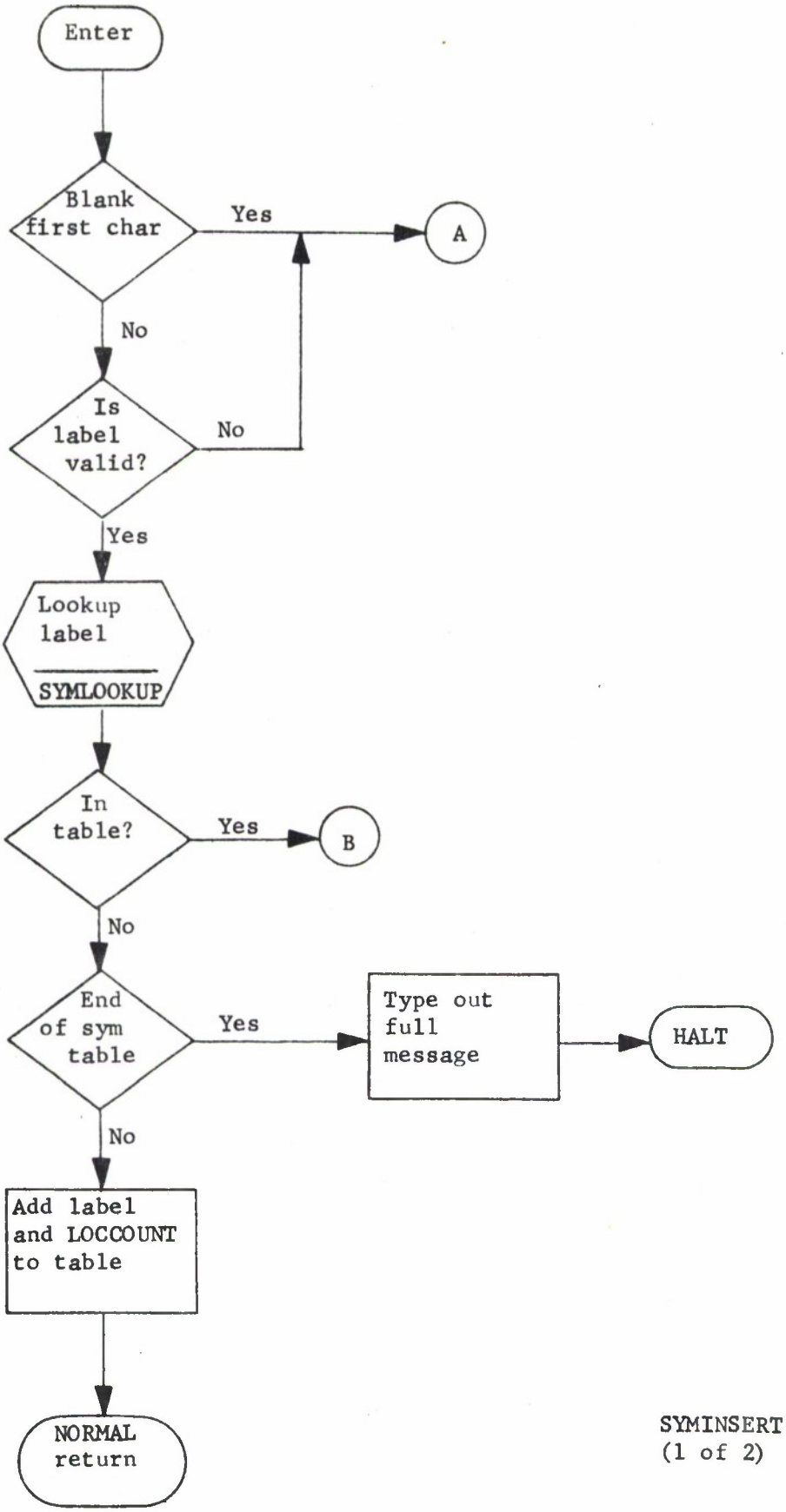
DEC TO OCT FLOW CHART
(1 of 1)



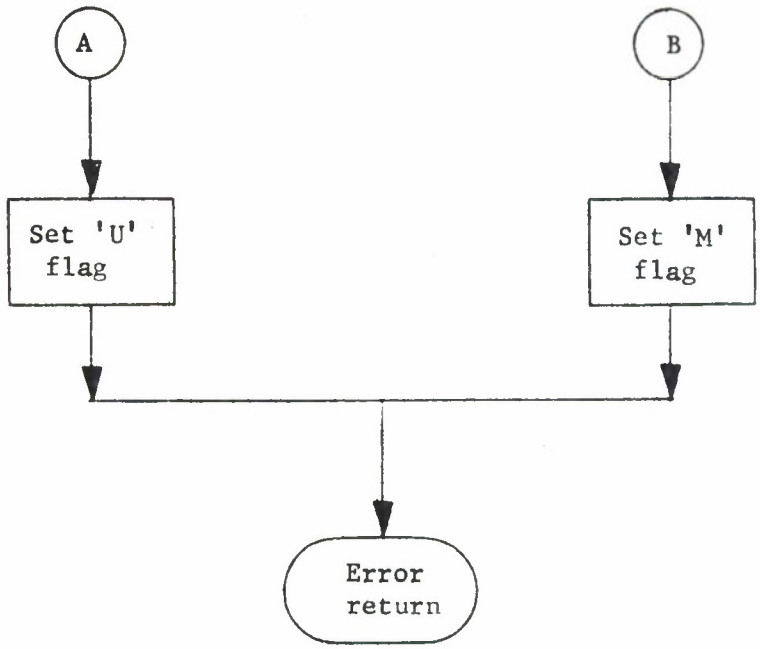
ADDOCTAL FLOW CHART
(1 of 1)



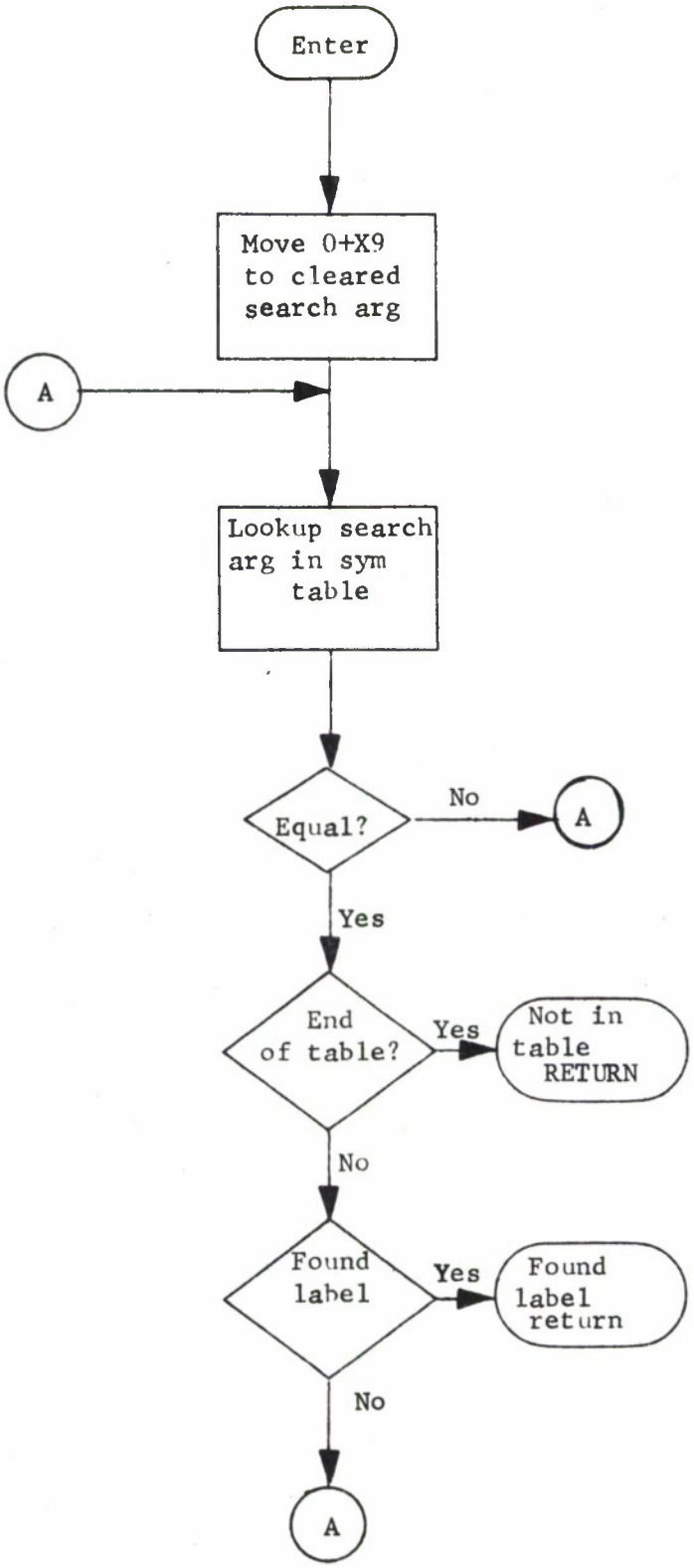
OPEXPLEG FLOW CHART
(1 of 1)



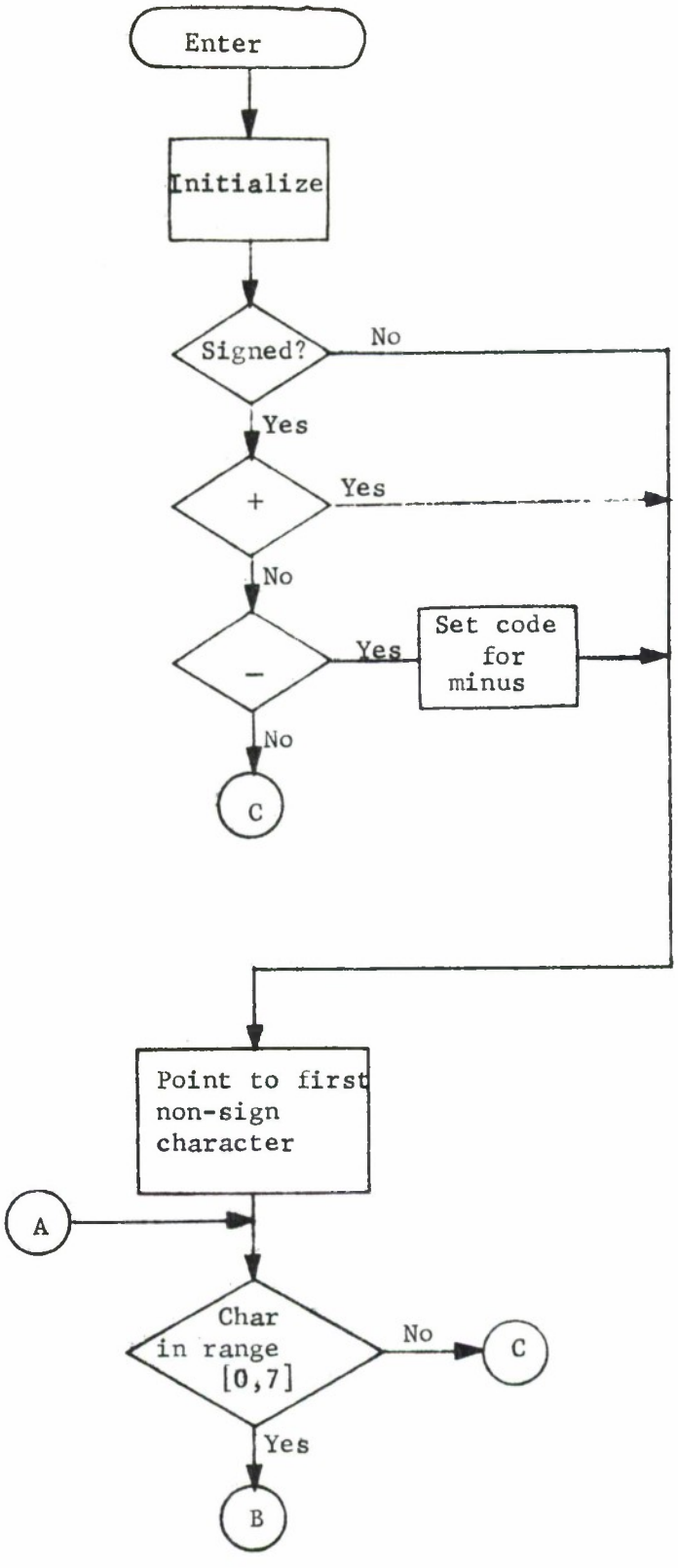
SYMINSERT FLOW CHART
(1 of 2)



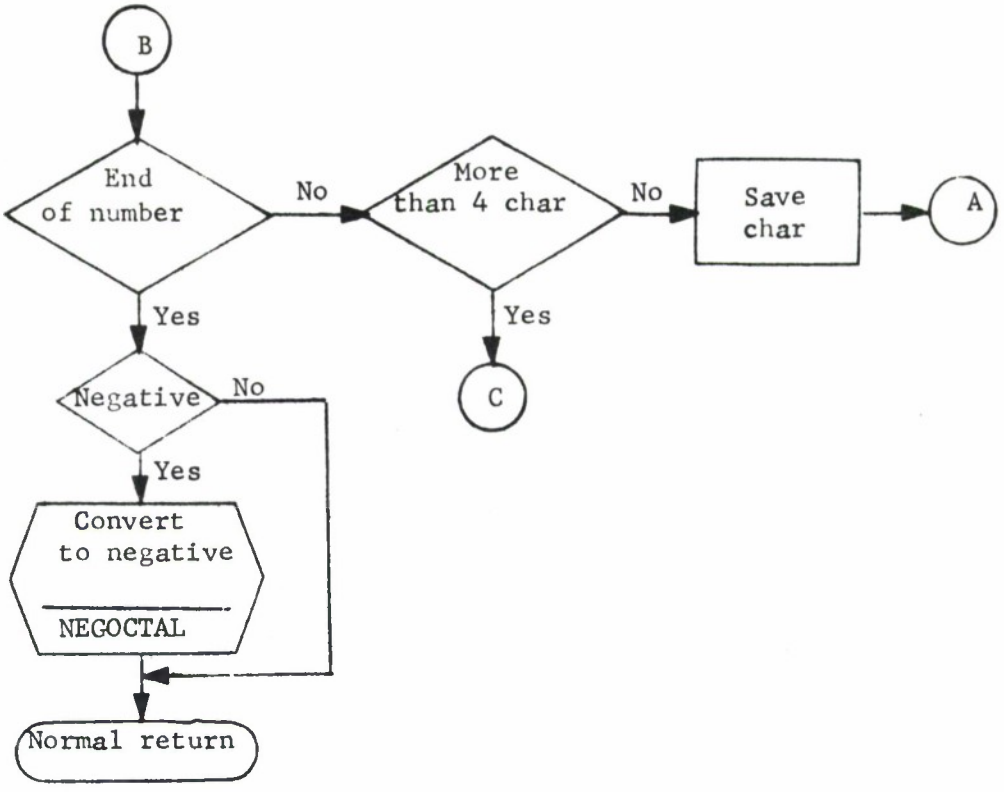
SYMINSERT
(2 of 2)

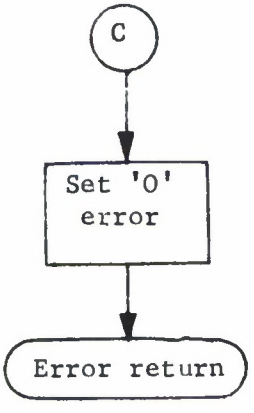


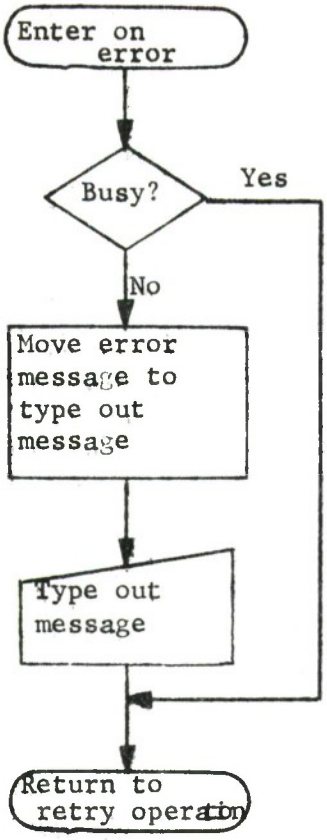
SYMLOOKUP FLOW CHART
(1 of 1)



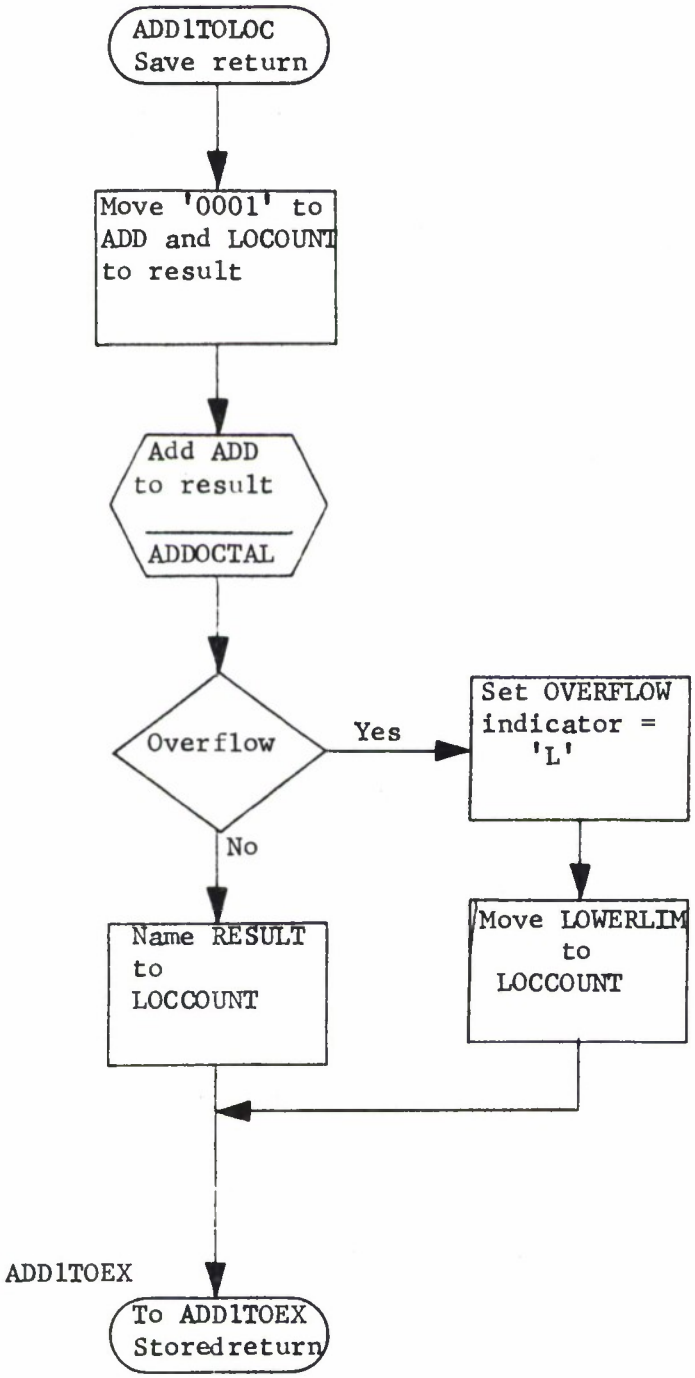
OCTALEXP FLOW CHART
(1 of 2)


B
End of number
No
More than 4 char
No
Save char
A
Yes
Yes
C
Negative
No
Yes
Convert to negative
NEGOCTAL
Normal return

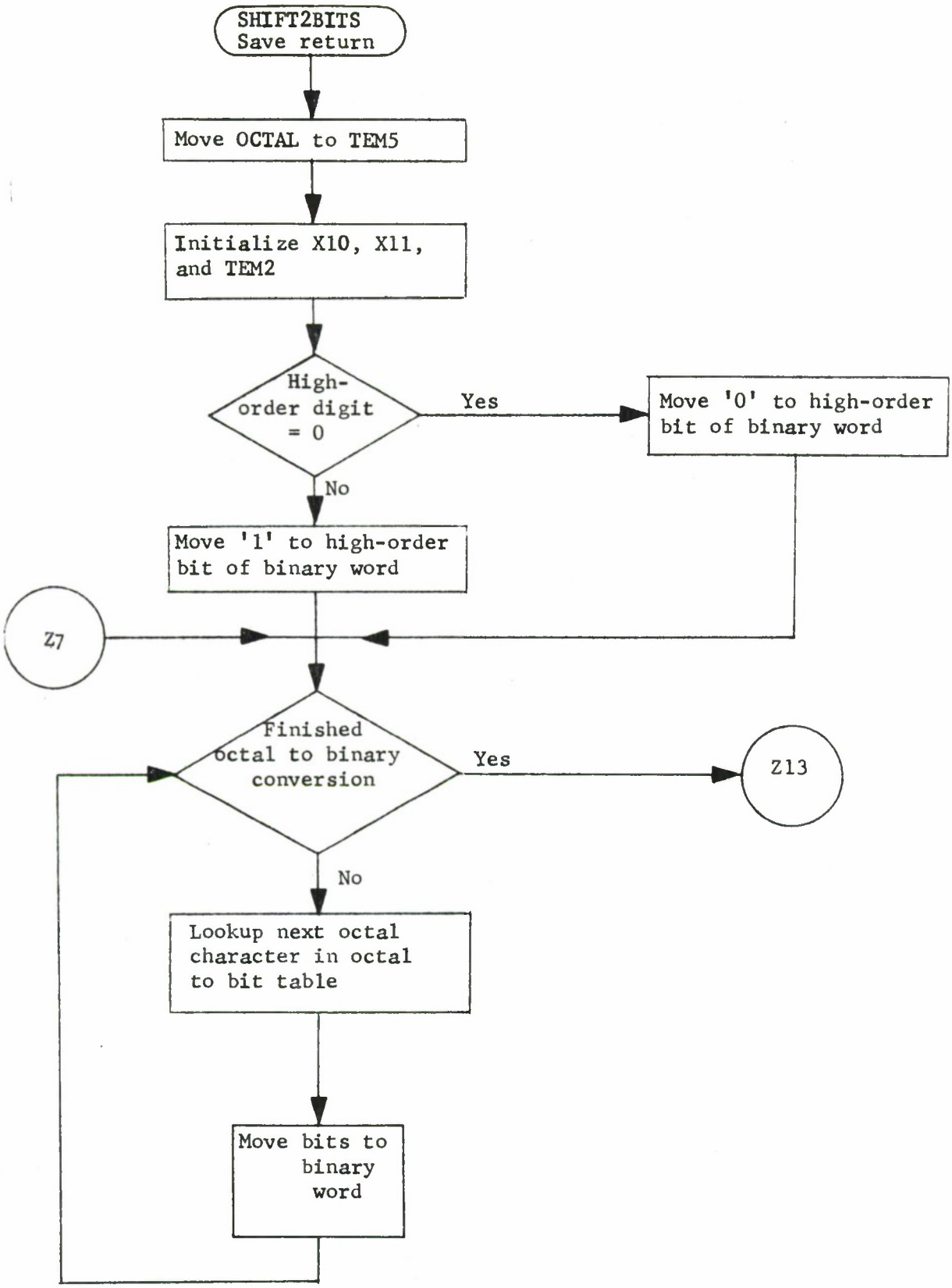

C
Set '0' error
Error return



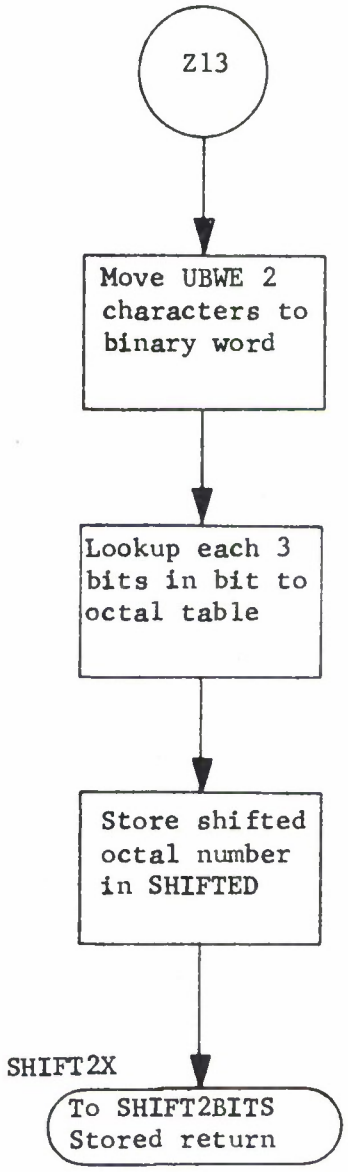
PRINTERR FLOW CHART
(1 of 1)

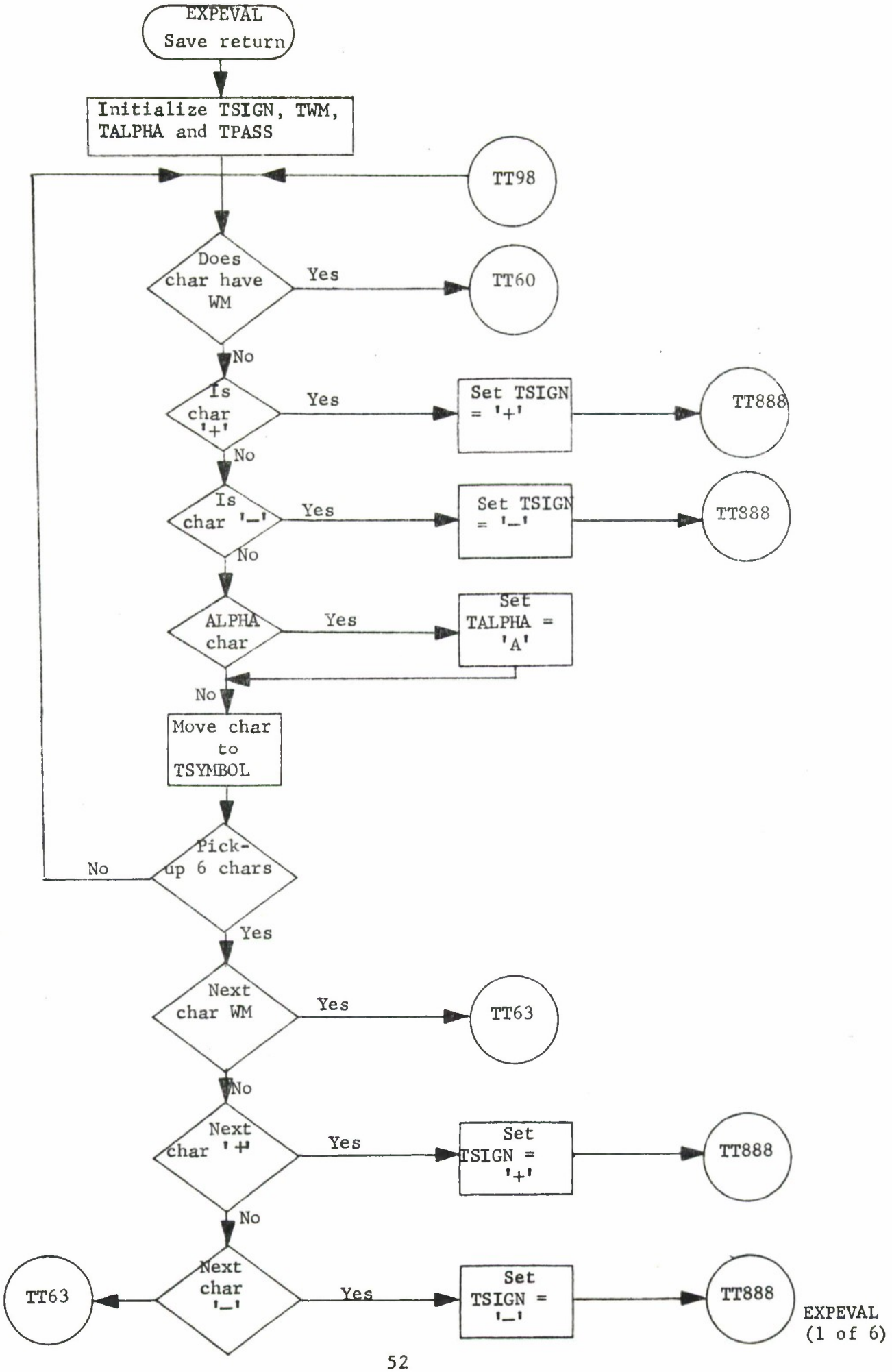


ADD1TOLOC FLOW CHART
(1 of 1)

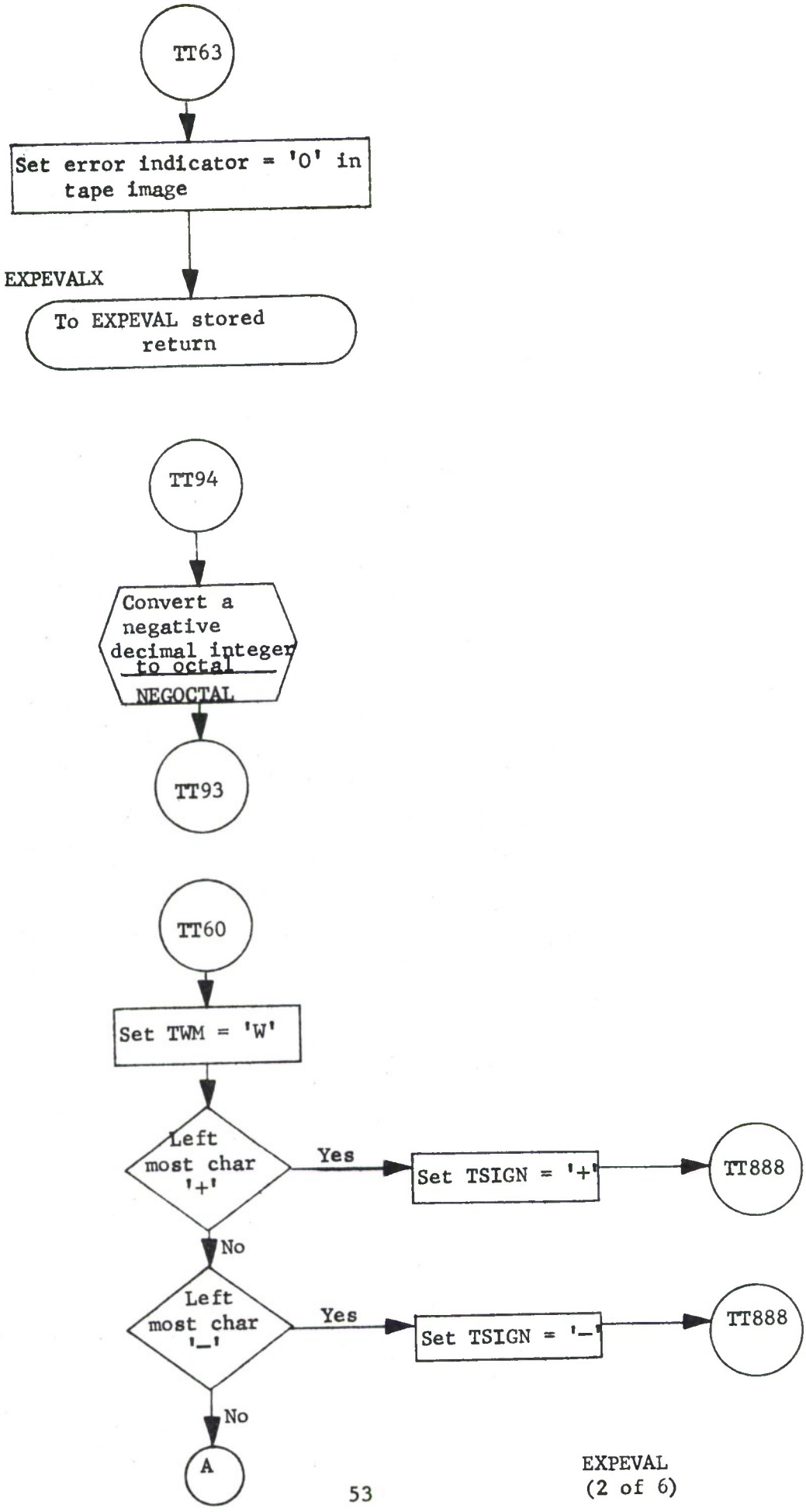


SHIFT2BITS FLOW CHART
(1 of 2)

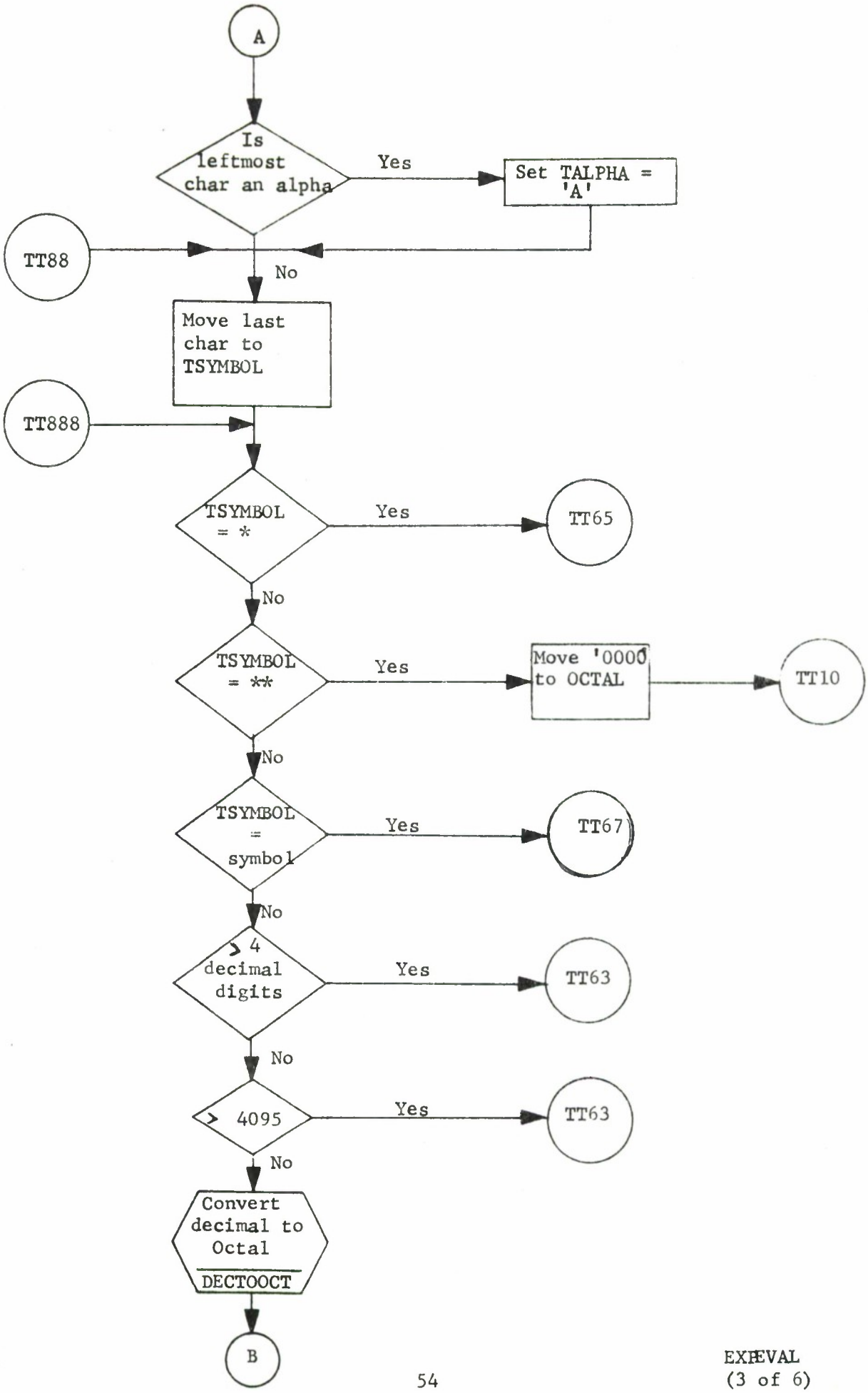

Z13
Move UBWE 2 characters to binary word
Lookup each 3 bits in bit to octal table
Store shifted octal number in SHIFTED
SHIFT2X
To SHIFT2BITS Stored return



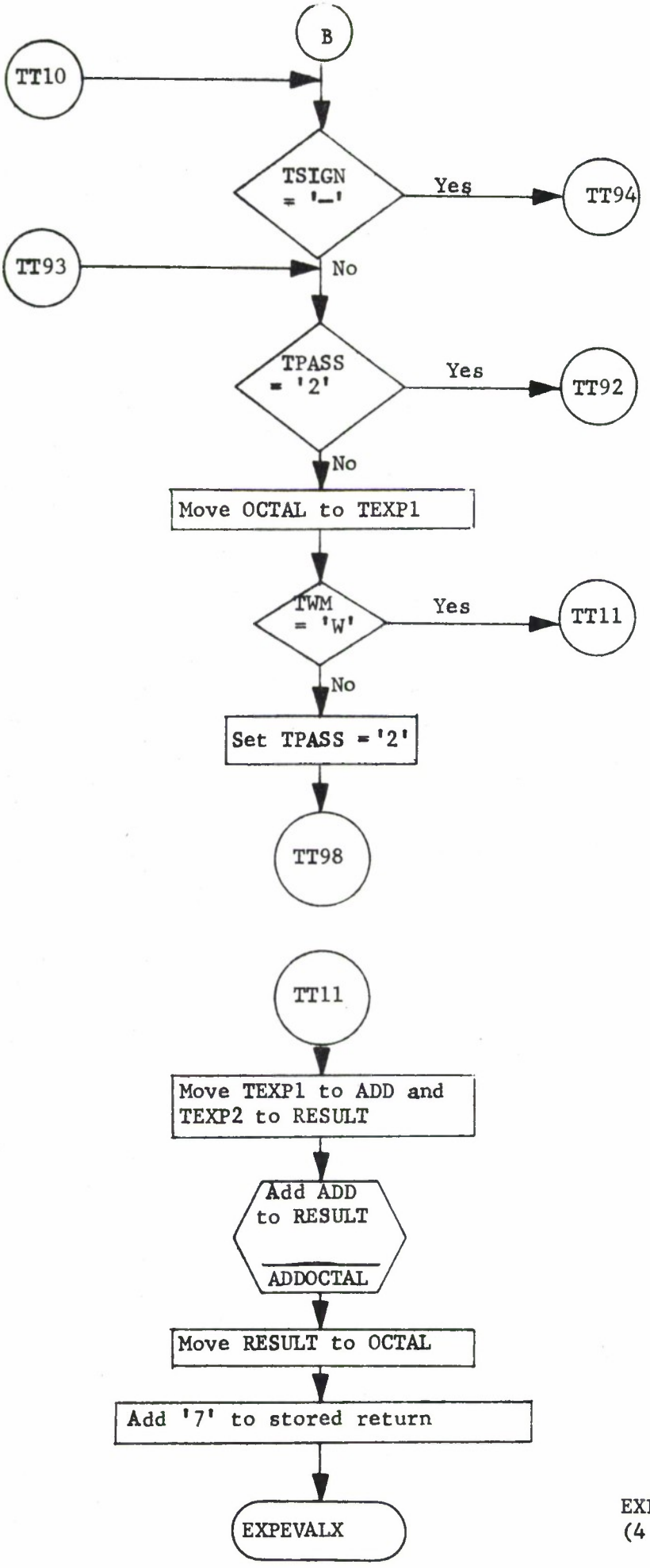
EXPEVAL
(1 of 6)



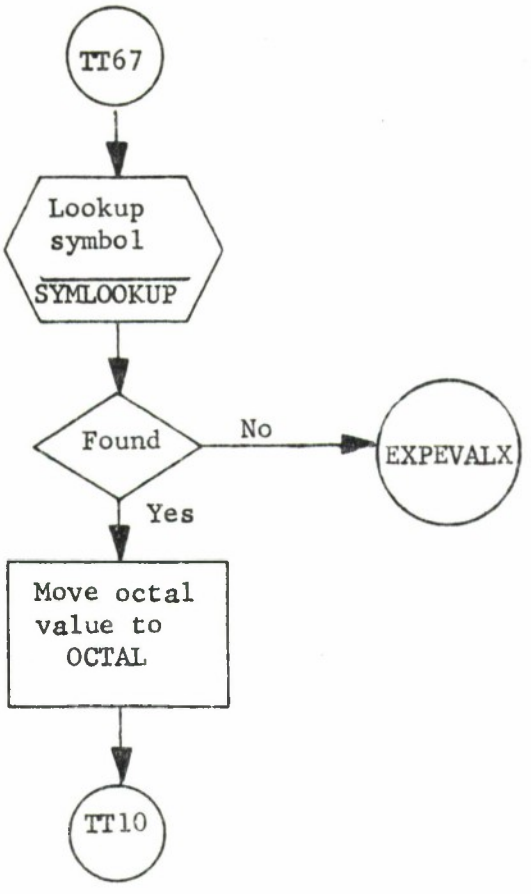
EXPEVAL
(2 of 6)

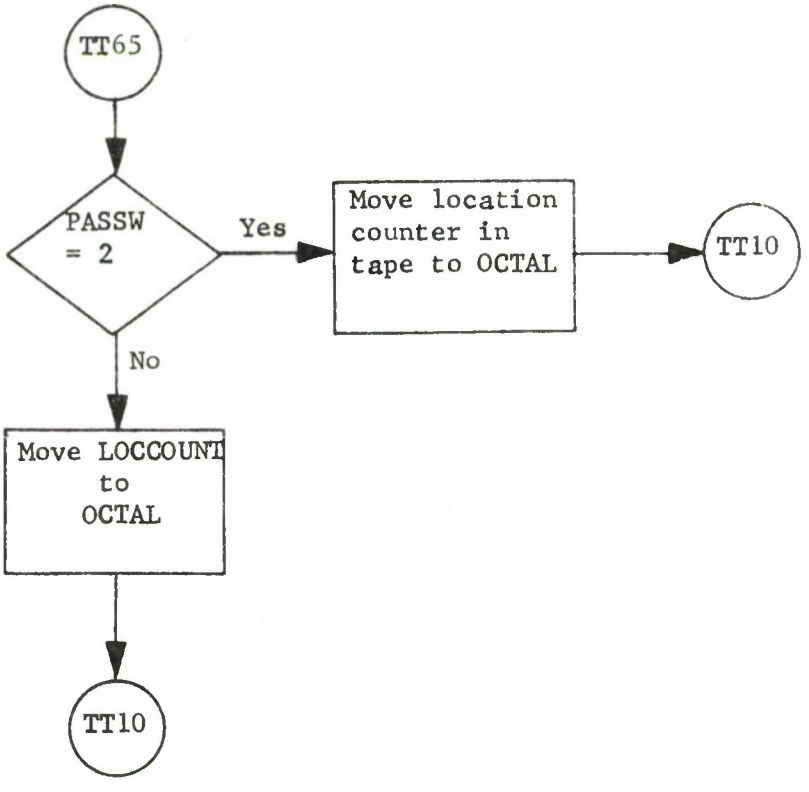

A
Is leftmost char an alpha
Yes
Set TALPHA = 'A'
TT88
No
Move last char to TSYMBOL
TT888
TSYMBOL = *
Yes
TT65
No
TSYMBOL = **
Yes
Move '0000 to OCTAL
TT10
No
TSYMBOL = symbol
Yes
TT67
No
> 4 decimal digits
Yes
TT63
No
> 4095
Yes
TT63
No
Convert decimal to Octal
DECTOOCT
B

EXEVAL
(3 of 6)

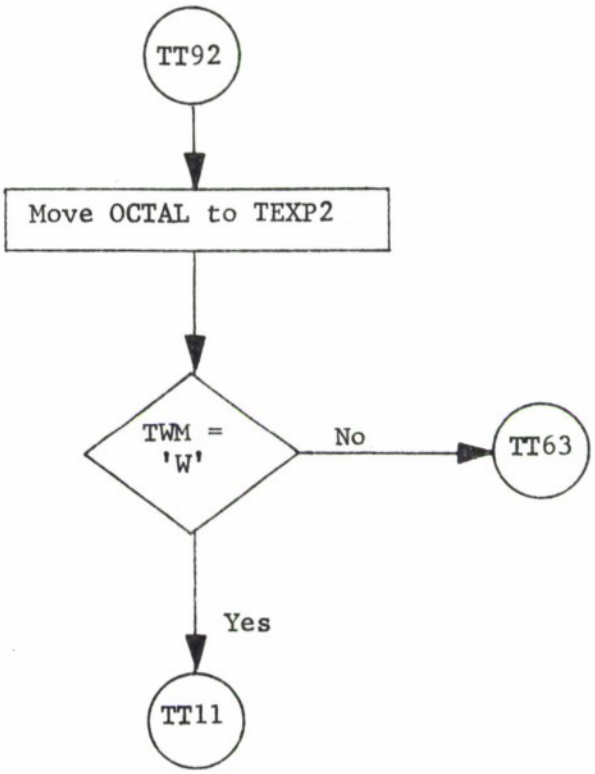


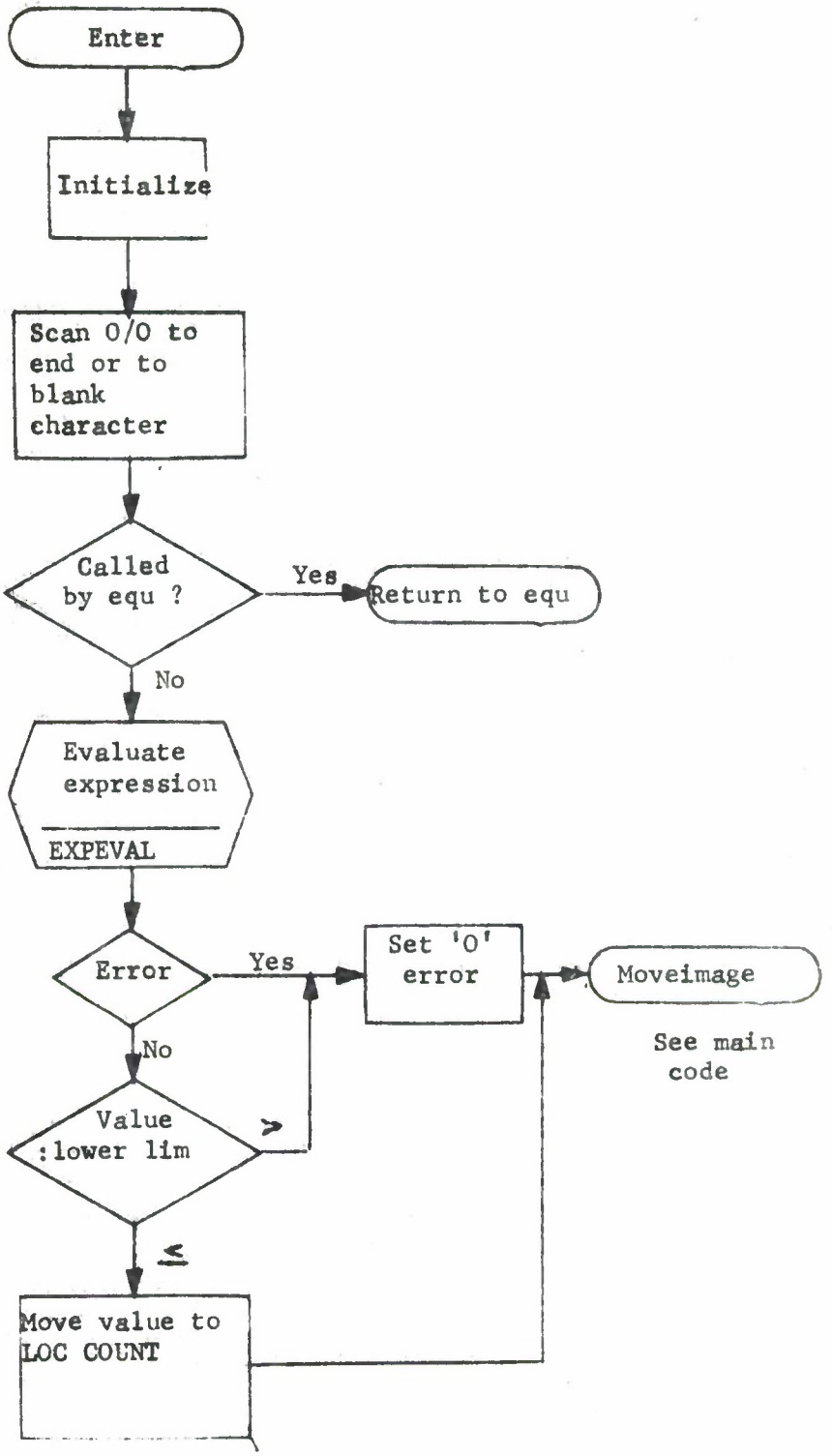
EXPEVAL
(4 of 6)



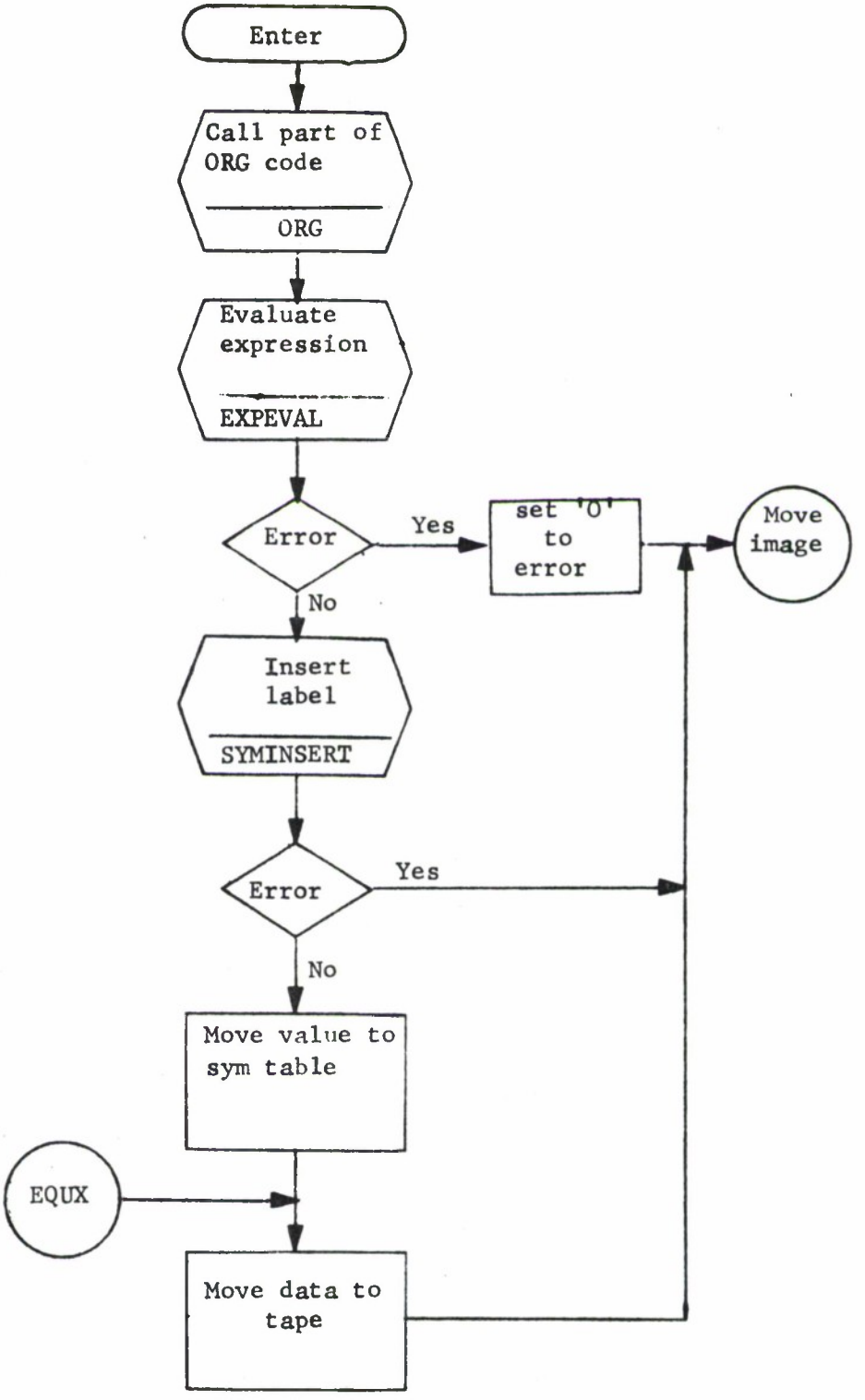


EXPEVAL
(5 of 6)

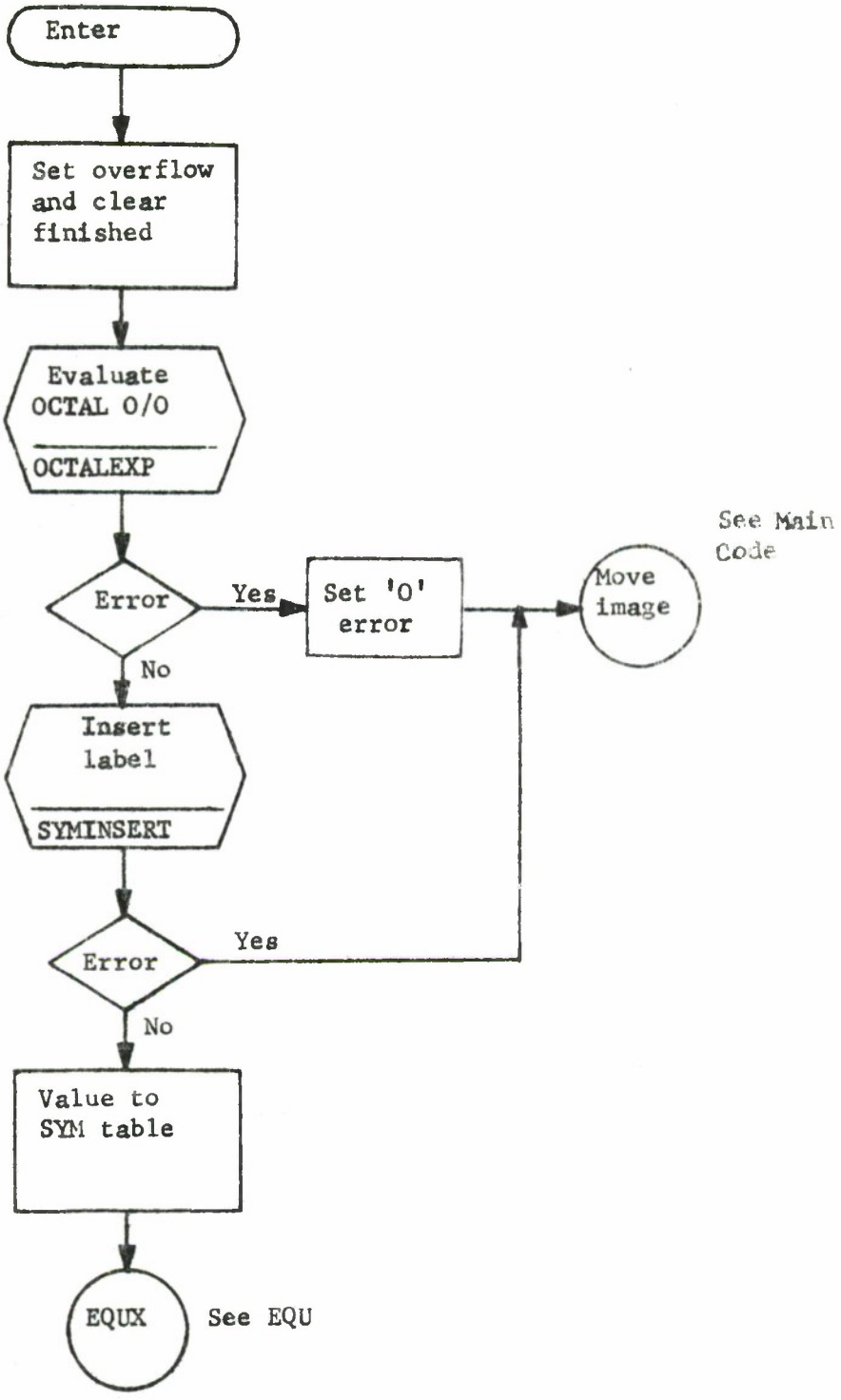

TT92
Move OCTAL to TEXP2
TWM =
'W'
No
TT63
Yes
TT11



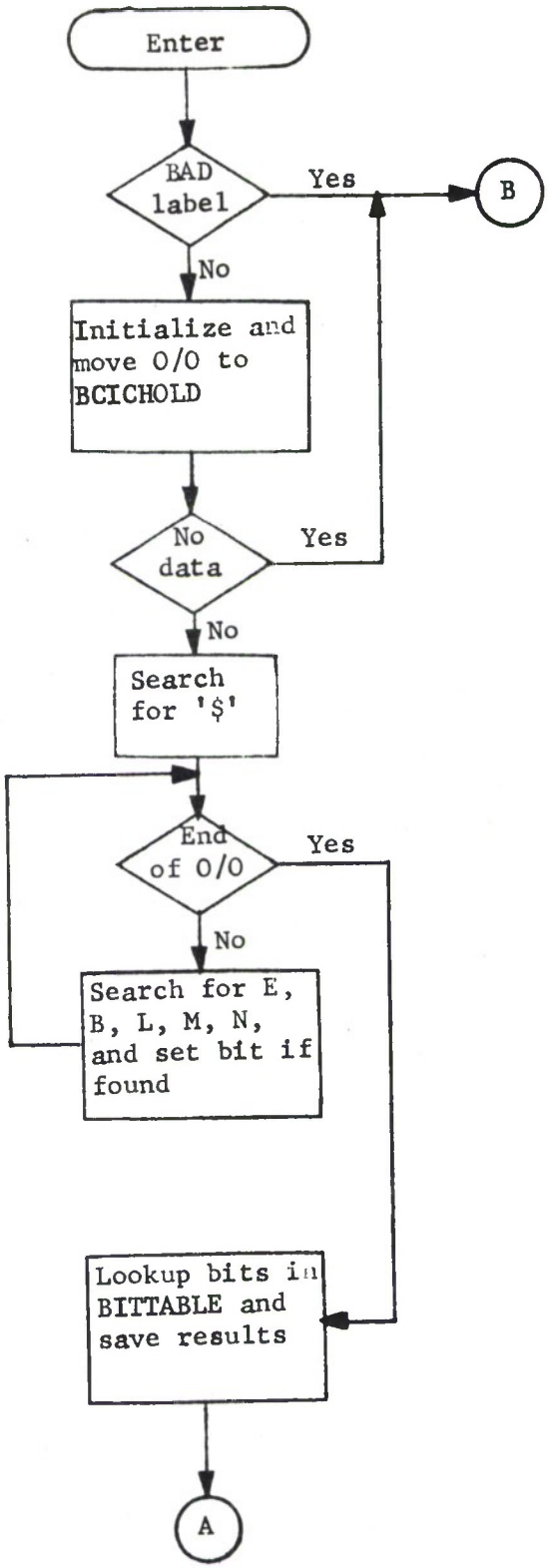
ORG FLOW CHART
(1 of 1)



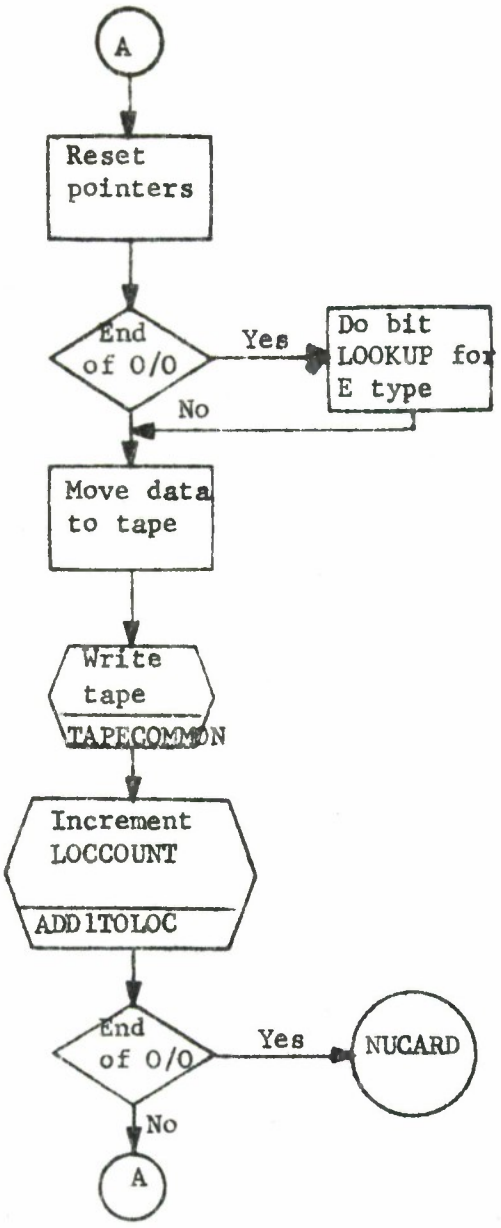
EQU FLOW CHART
(1 of 1)



EQUB FLOW CHART
(1 of 1)

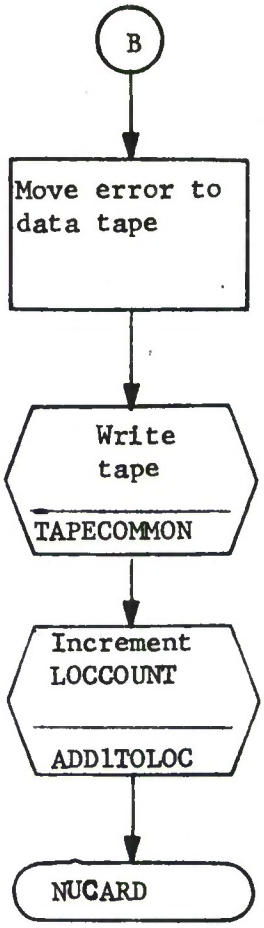


BCIC FLOW CHART
(1 of 3)

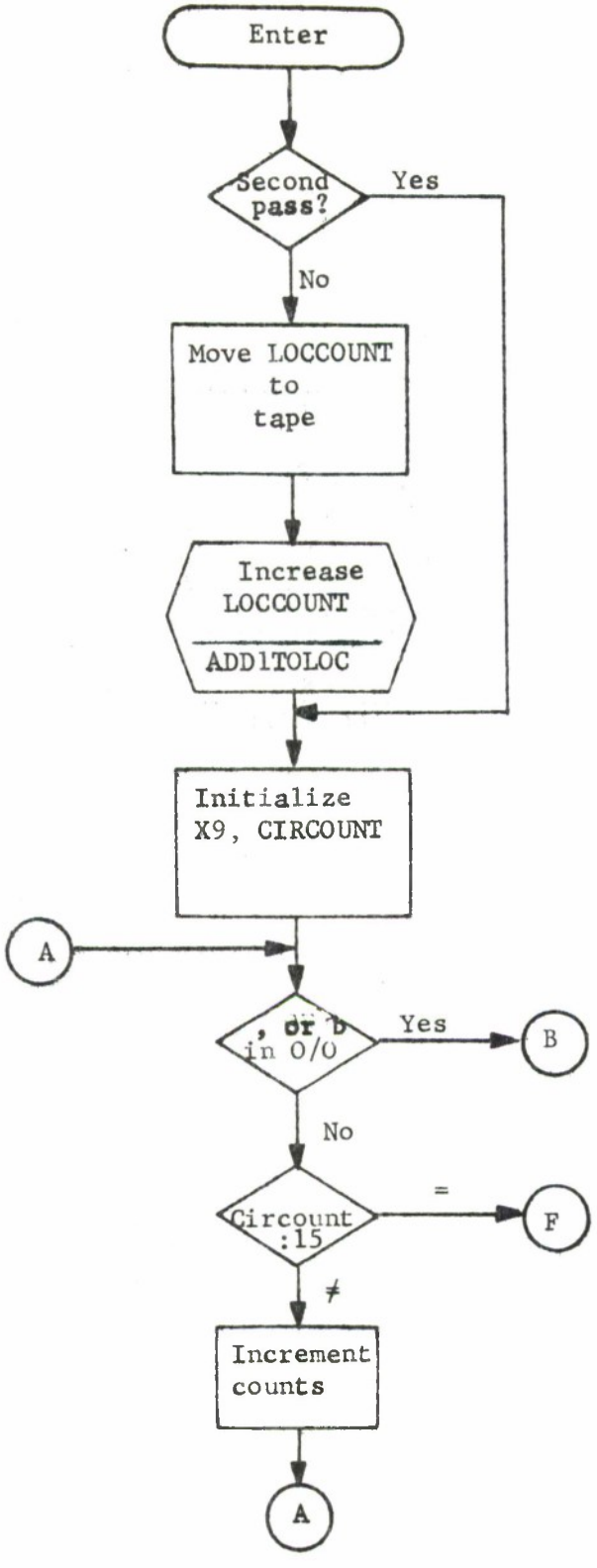


See main flow

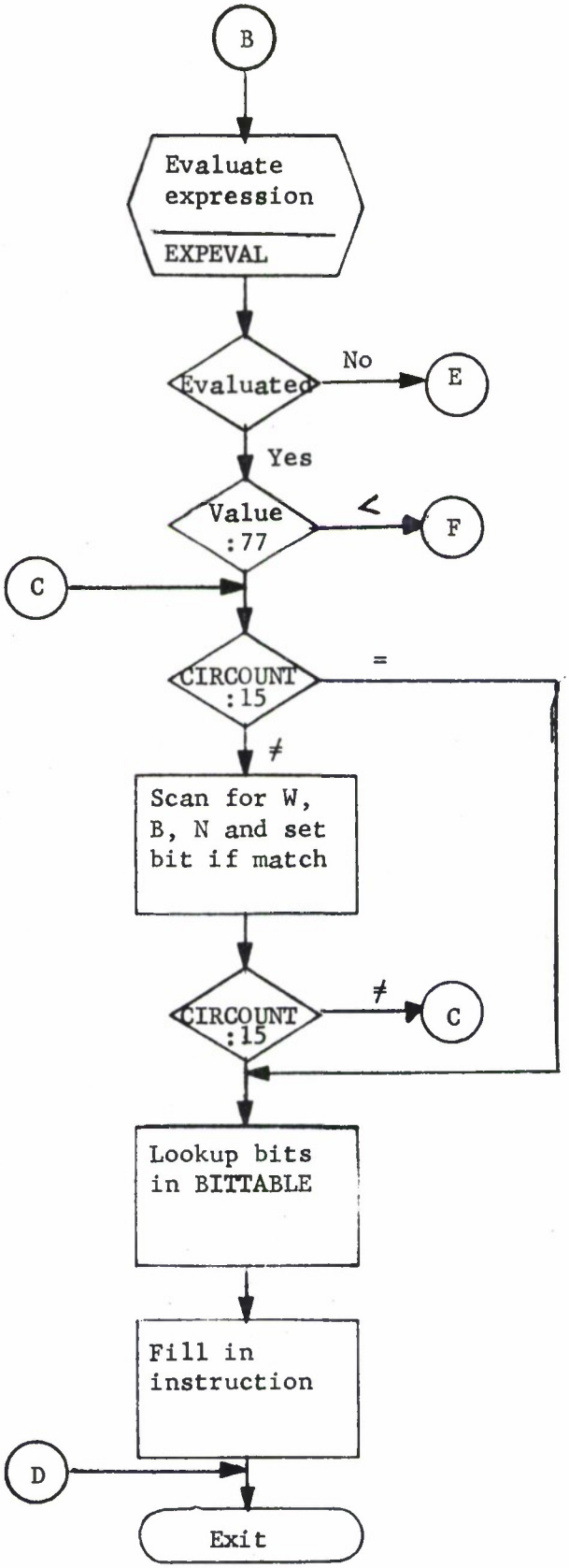
BCIC
(2 of 3)

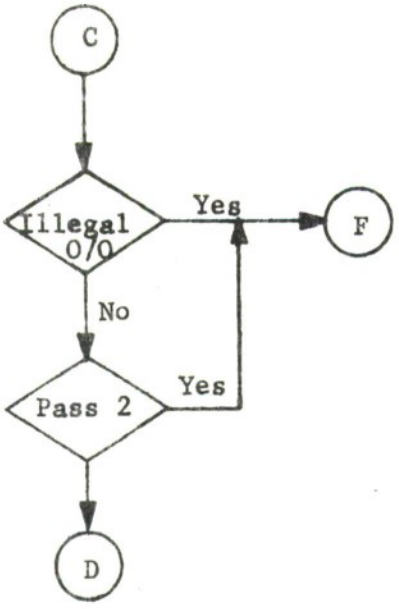

B
Move error to data tape
Write tape
TAPECOMMON
Increment LOCCOUNT
ADD1TOLOC
NUCARD

BCIC
(3 of 3)

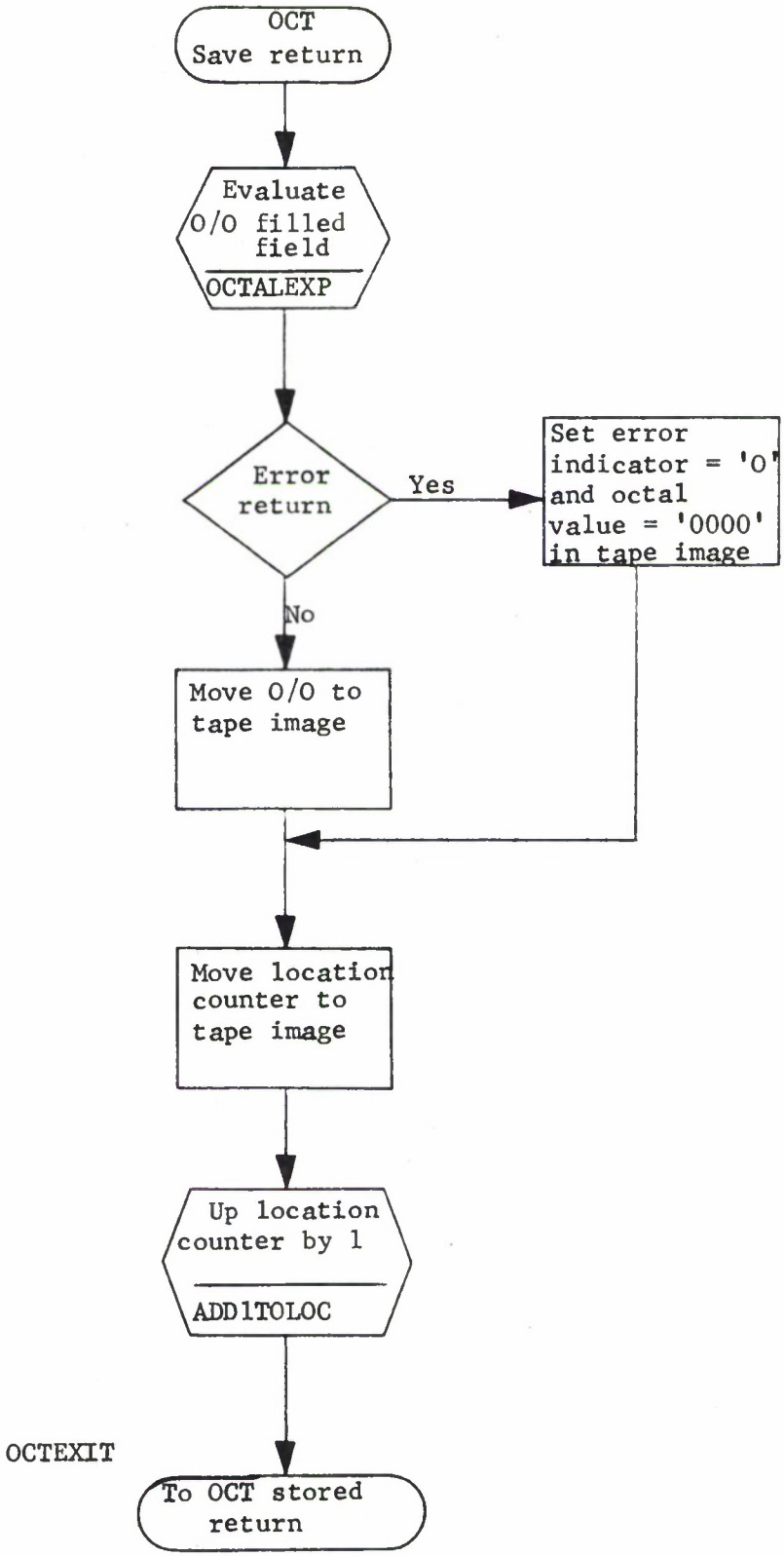


CIR FLOW CHART
(1 of 3)

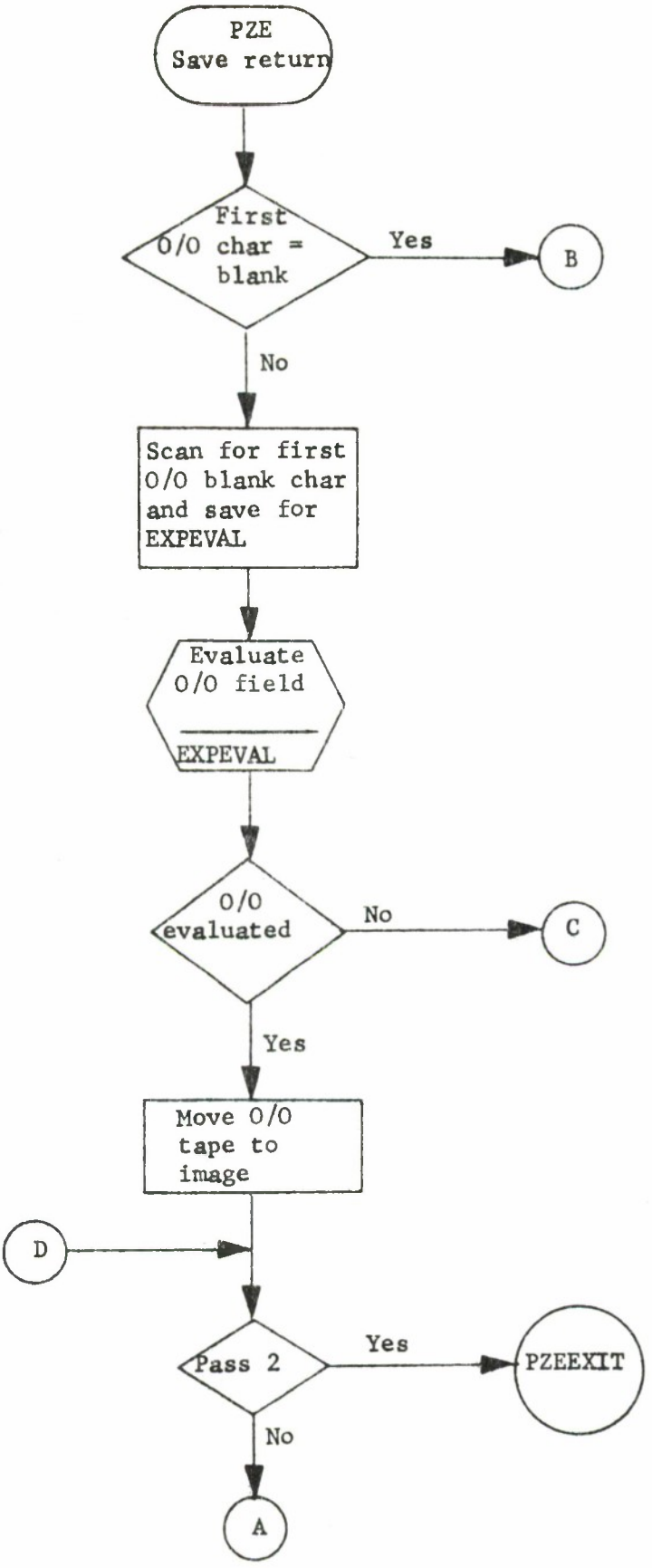

B
Evaluate expression
EXPEVAL
Evaluated
No
E
Yes
Value :77
<
F
C
CIRCOUNT :15
=
≠
Scan for W, B, N and set bit if match
CIRCOUNT :15
≠
C
Lookup bits in BITTABLE
Fill in instruction
D
Exit



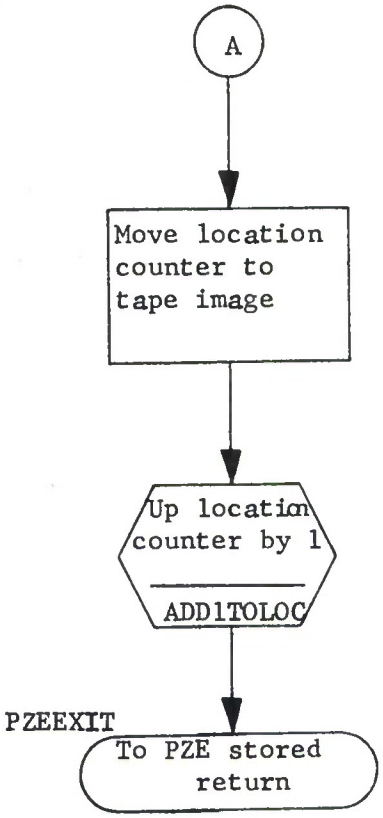
CIR
(3 of 3)

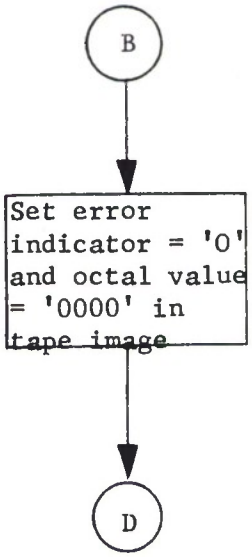


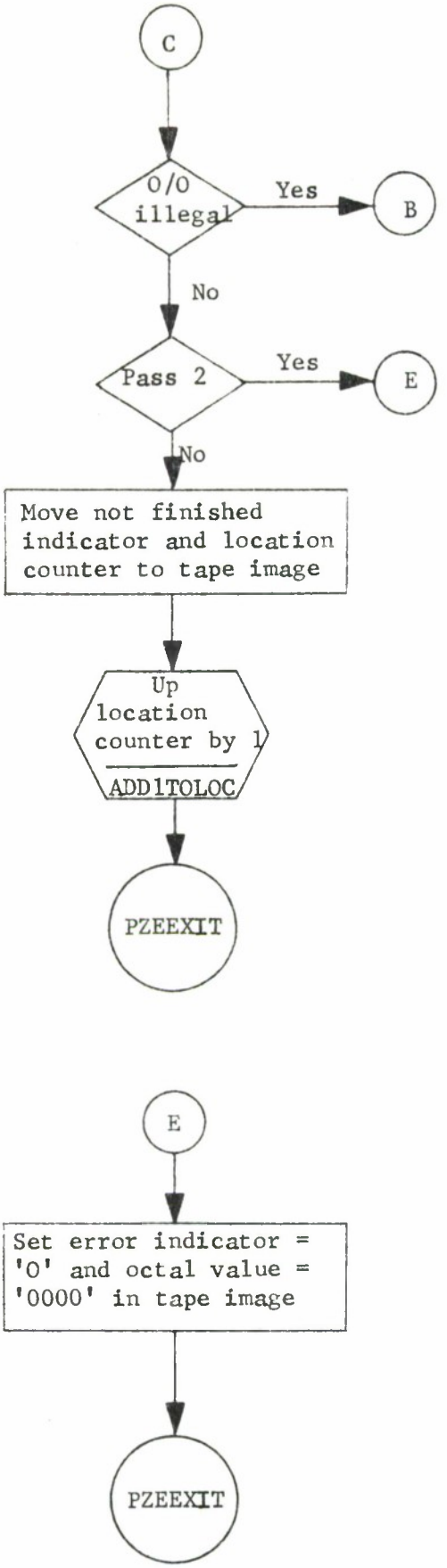
OCT FLOW CHART
(1 of 1)



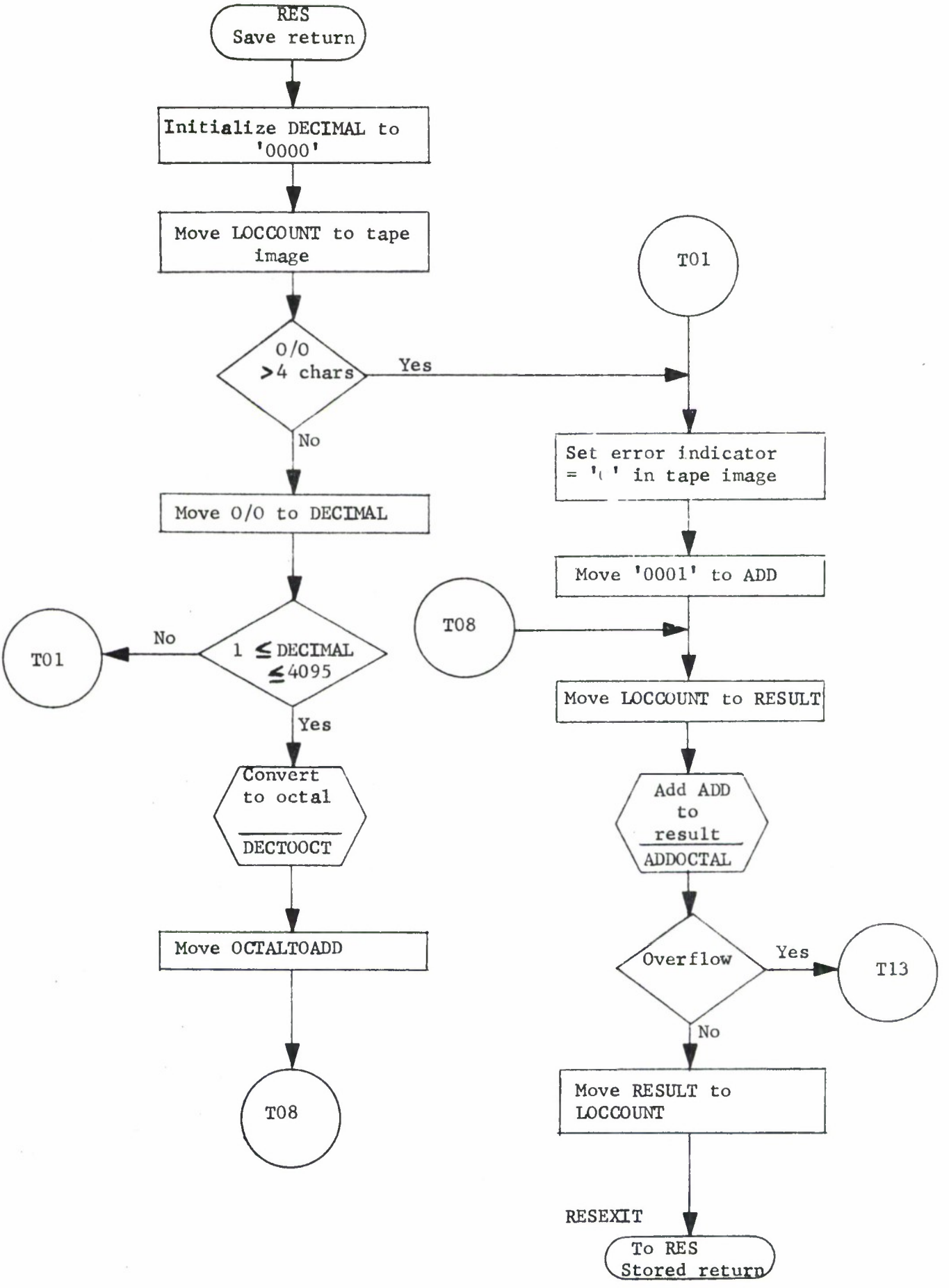
PZE FLOW CHART
(1 of 3)


A
Move location counter to tape image
Up location counter by 1
ADD1TOLOC
PZEEXIT
To PZE stored return

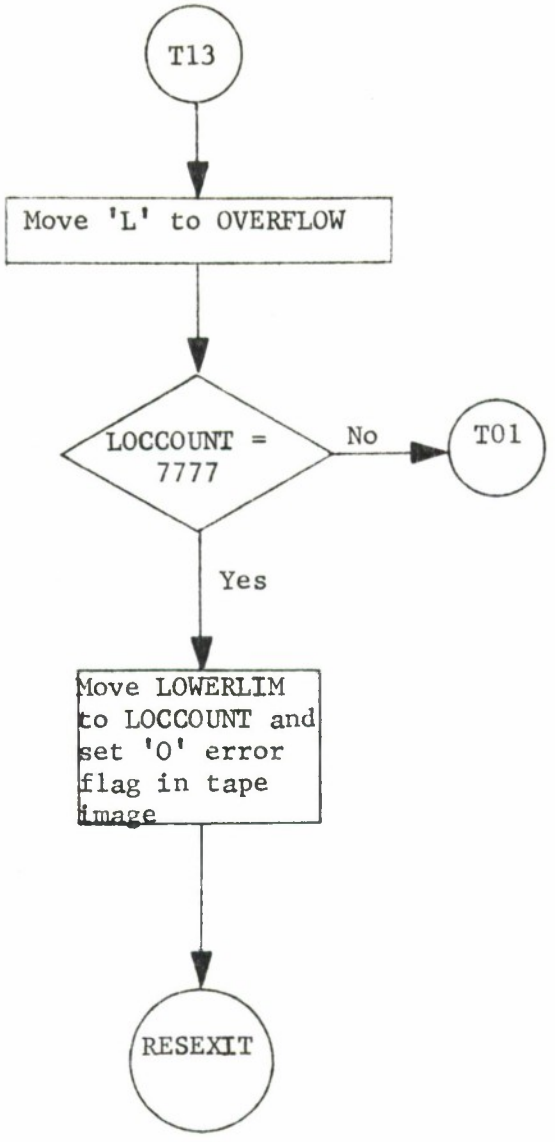

B
Set error indicator = '0' and octal value = '0000' in tape image
D


C
0/0 illegal
Yes
B
No
Pass 2
Yes
E
No
Move not finished indicator and location counter to tape image
Up location counter by 1
ADD1TOLOC
PZEEXIT
E
Set error indicator = '0' and octal value = '0000' in tape image
PZEEXIT

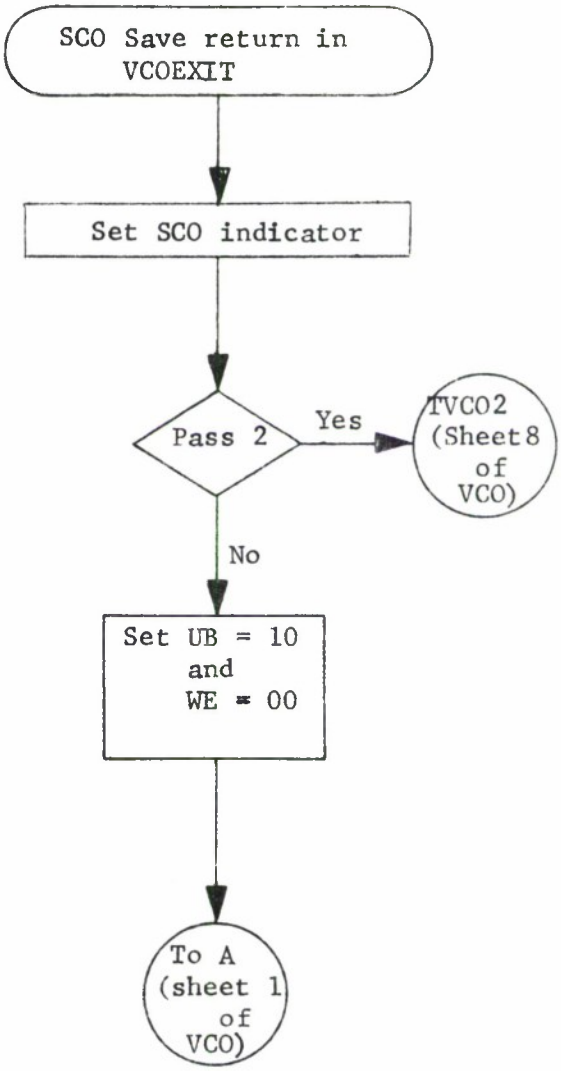
PZE
(3 of 3)



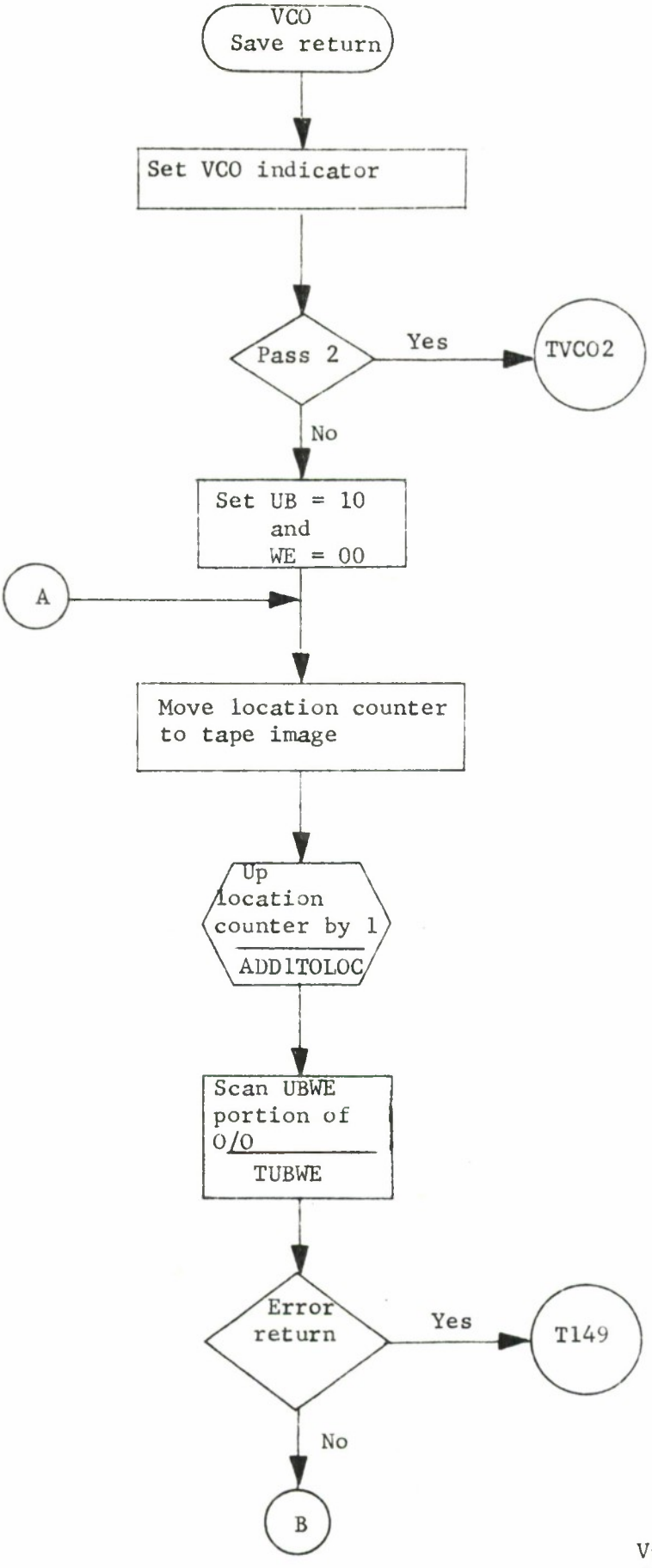
RES FLOW CHART
(1 of 2)


T13
Move 'L' to OVERFLOW
LOCCOUNT = 7777
No
T01
Yes
Move LOWERLIM to LOCCOUNT and set '0' error flag in tape image
RESEXIT

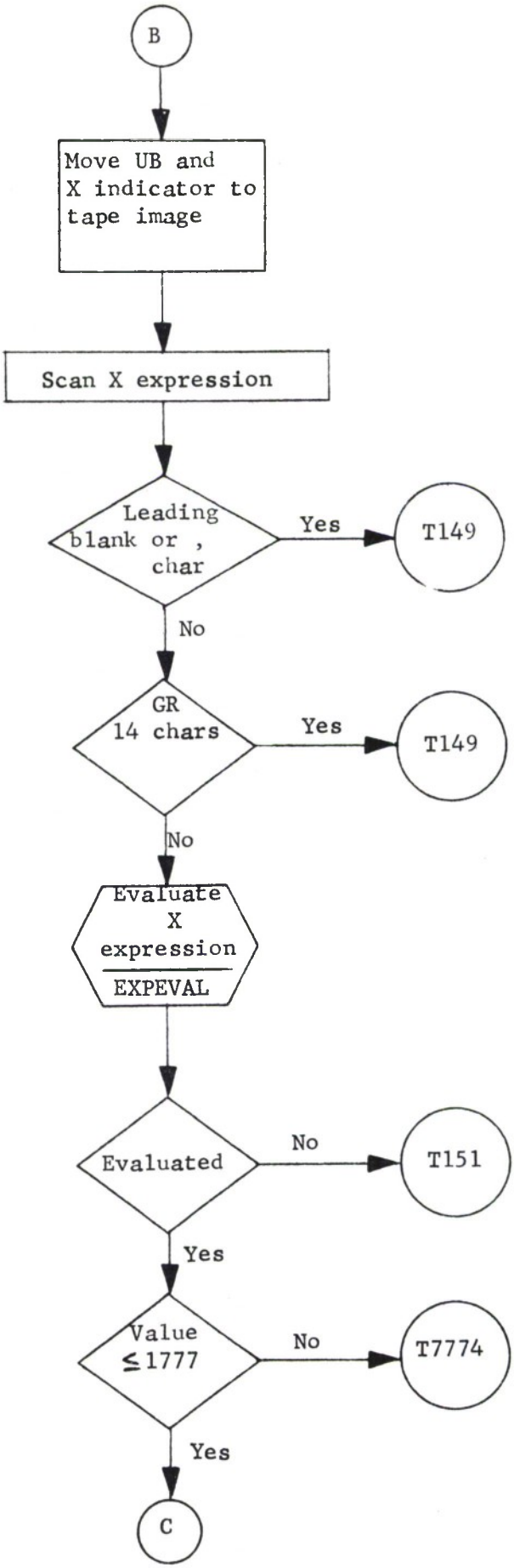
RES
(2 of 2)



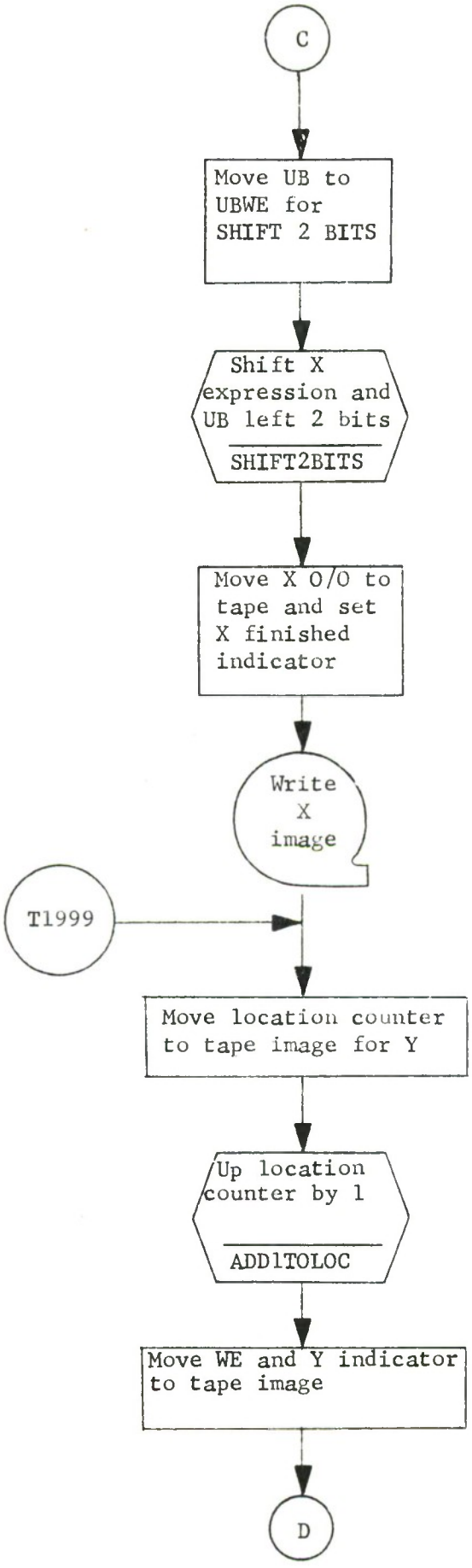
SCO Flow Chart
(1 of 1)



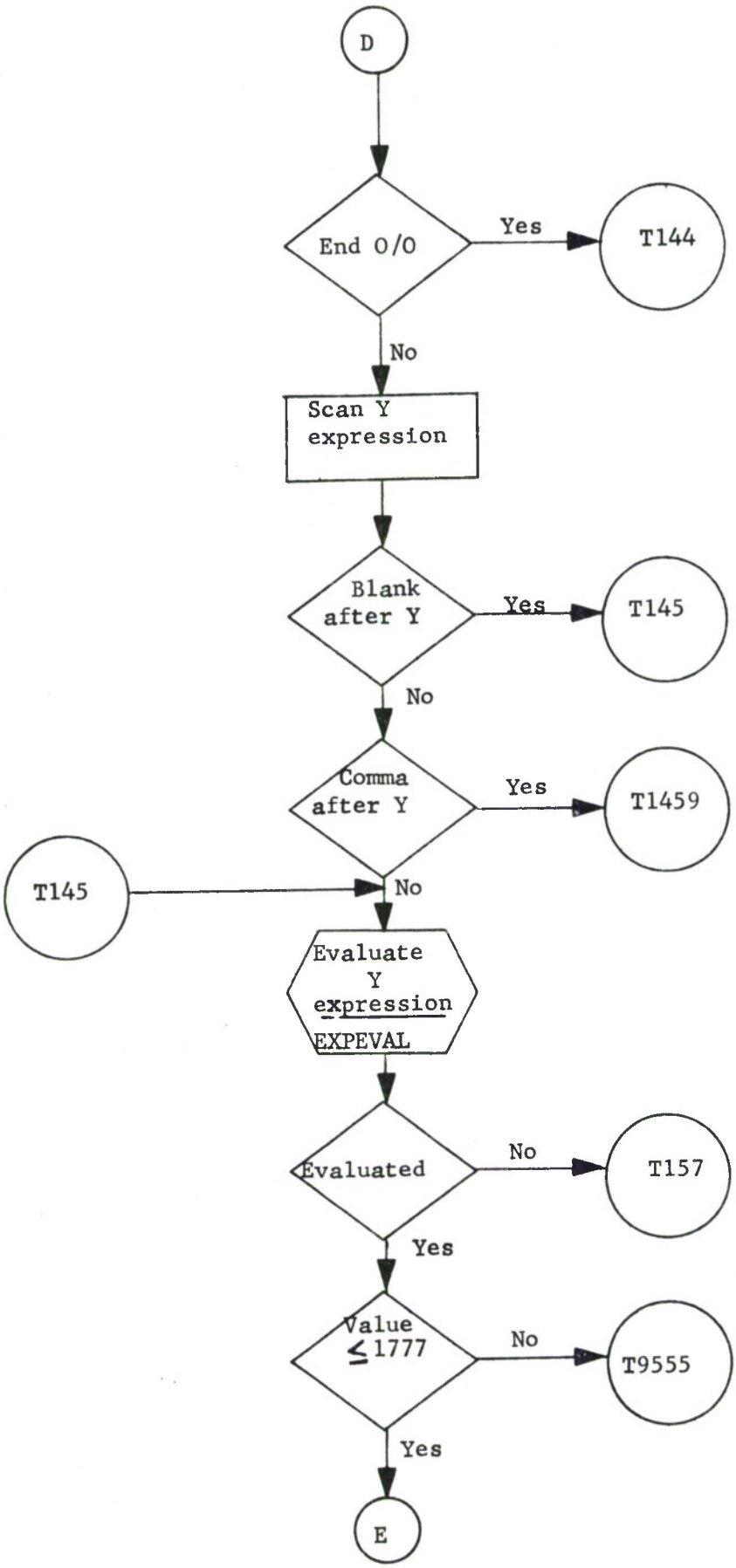
VCO Flow Chart
(1 of 9)


B
Move UB and X indicator to tape image
Scan X expression
Leading blank or , char
Yes
T149
No
GR 14 chars
Yes
T149
No
Evaluate X expression
EXPEVAL
Evaluated
No
T151
Yes
Value ≤1777
No
T7774
Yes
C

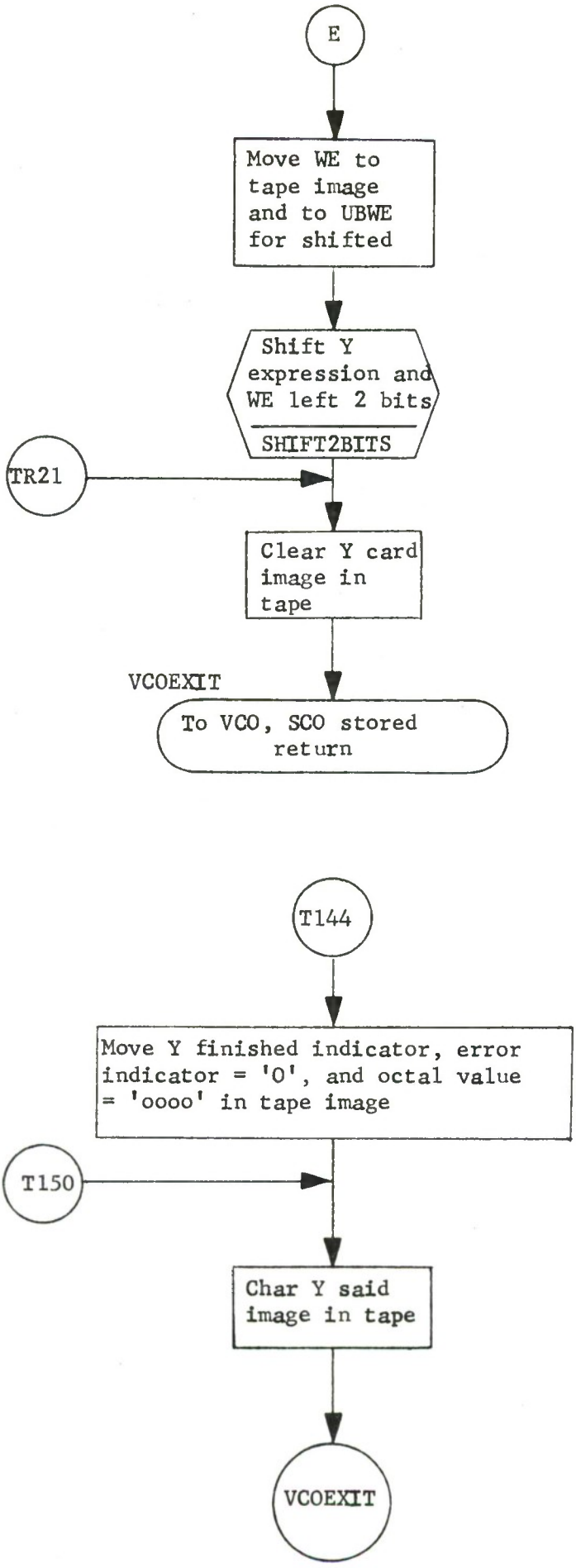
VCO
(2 of 9)


C
Move UB to UBWE for SHIFT 2 BITS
Shift X expression and UB left 2 bits
SHIFT2BITS
Move X 0/0 to tape and set X finished indicator
Write X image
T1999
Move location counter to tape image for Y
Up location counter by 1
ADD1TOLOC
Move WE and Y indicator to tape image
D

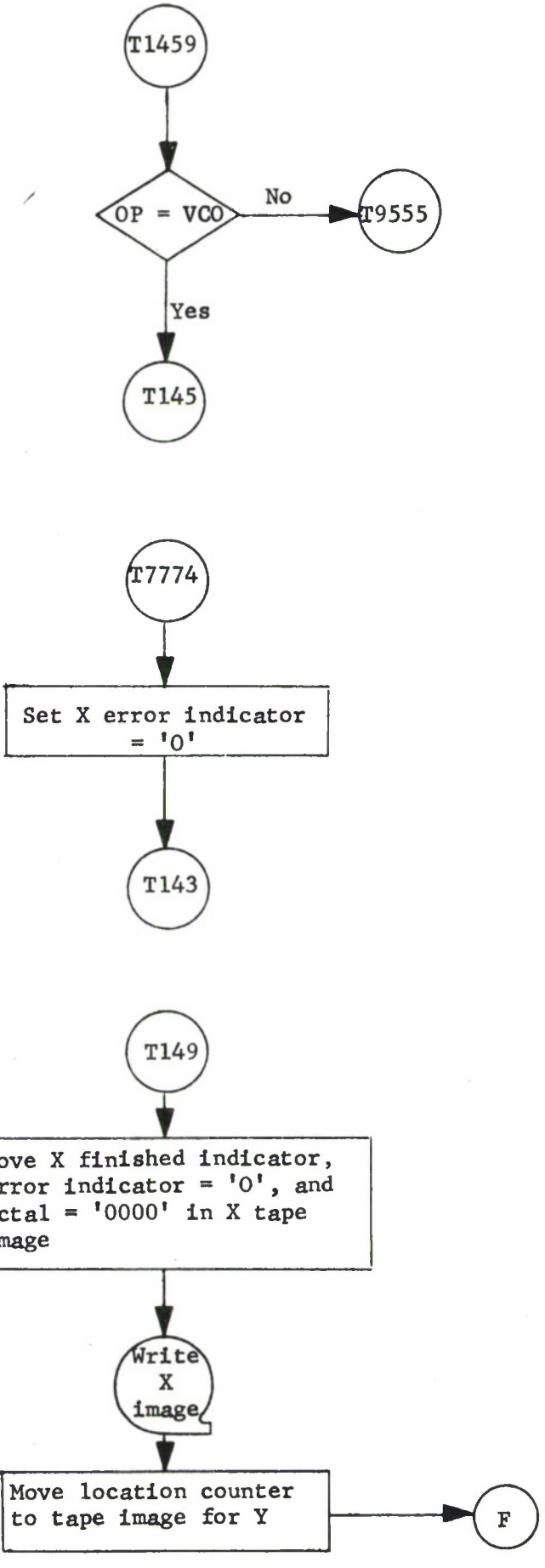
VCO
(3 of 9)


D
End 0/0
Yes
T144
No
Scan Y expression
Blank after Y
Yes
T145
No
Comma after Y
Yes
T1459
T145
No
Evaluate Y expression EXPEVAL
Evaluated
No
T157
Yes
Value ≤1777
No
T9555
Yes
E

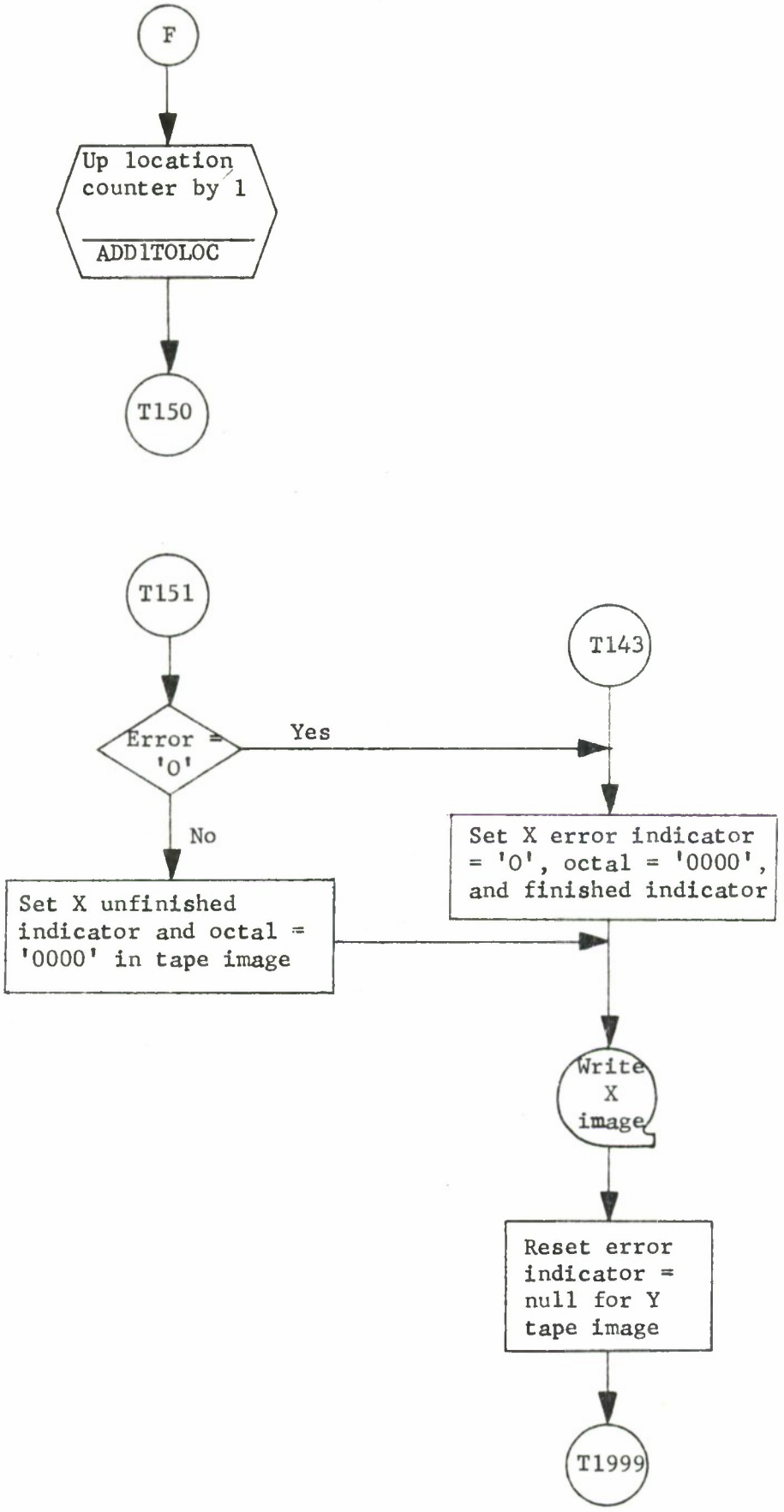
VCO
(4 of 9)


E
Move WE to tape image and to UBWE for shifted
Shift Y expression and WE left 2 bits
SHIFT2BITS
TR21
Clear Y card image in tape
VCOEXIT
To VCO, SCO stored return
T144
Move Y finished indicator, error indicator = '0', and octal value = 'oooo' in tape image
T150
Char Y said image in tape
VCOEXIT

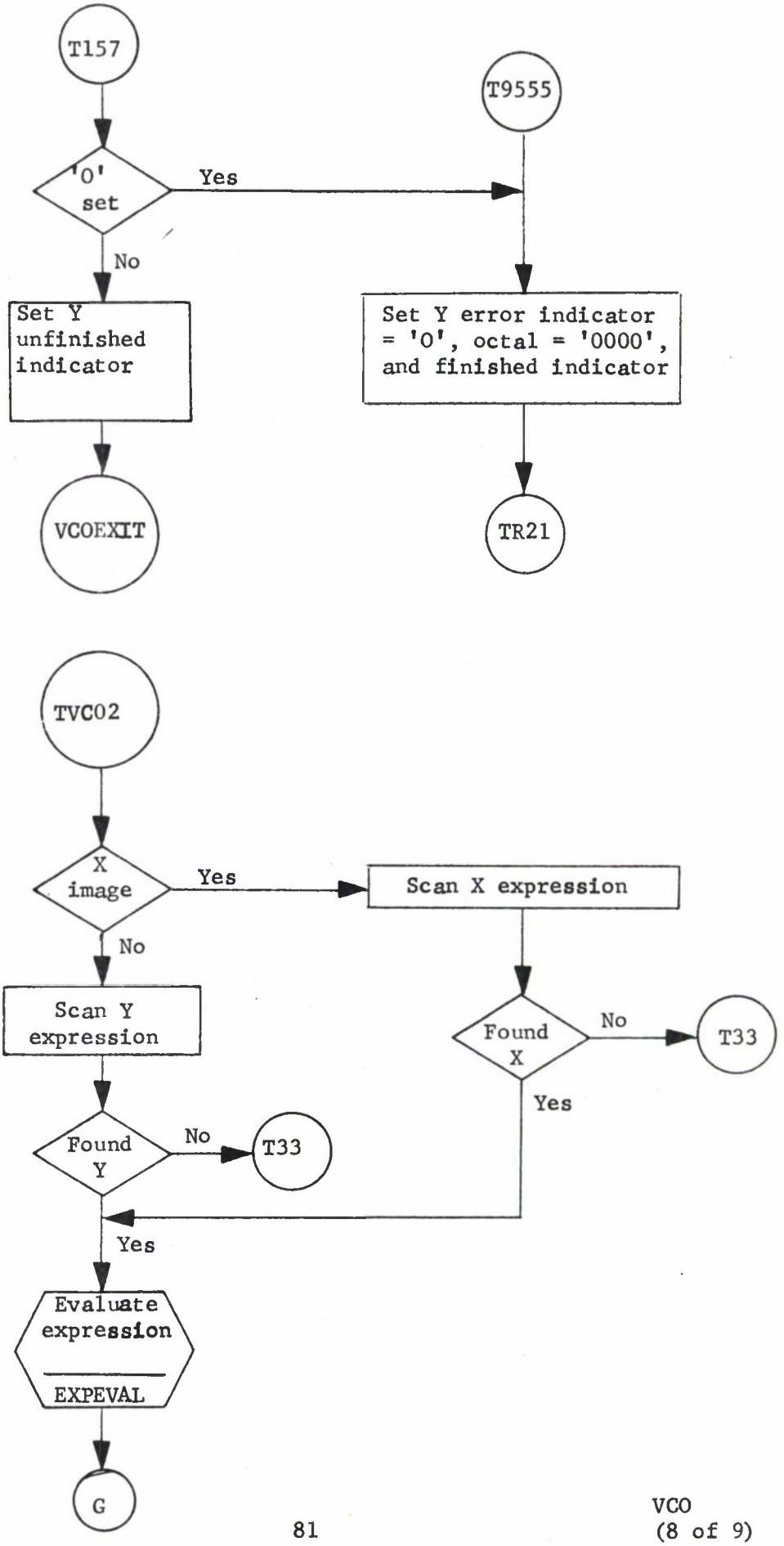
VCO
(5 of 9)

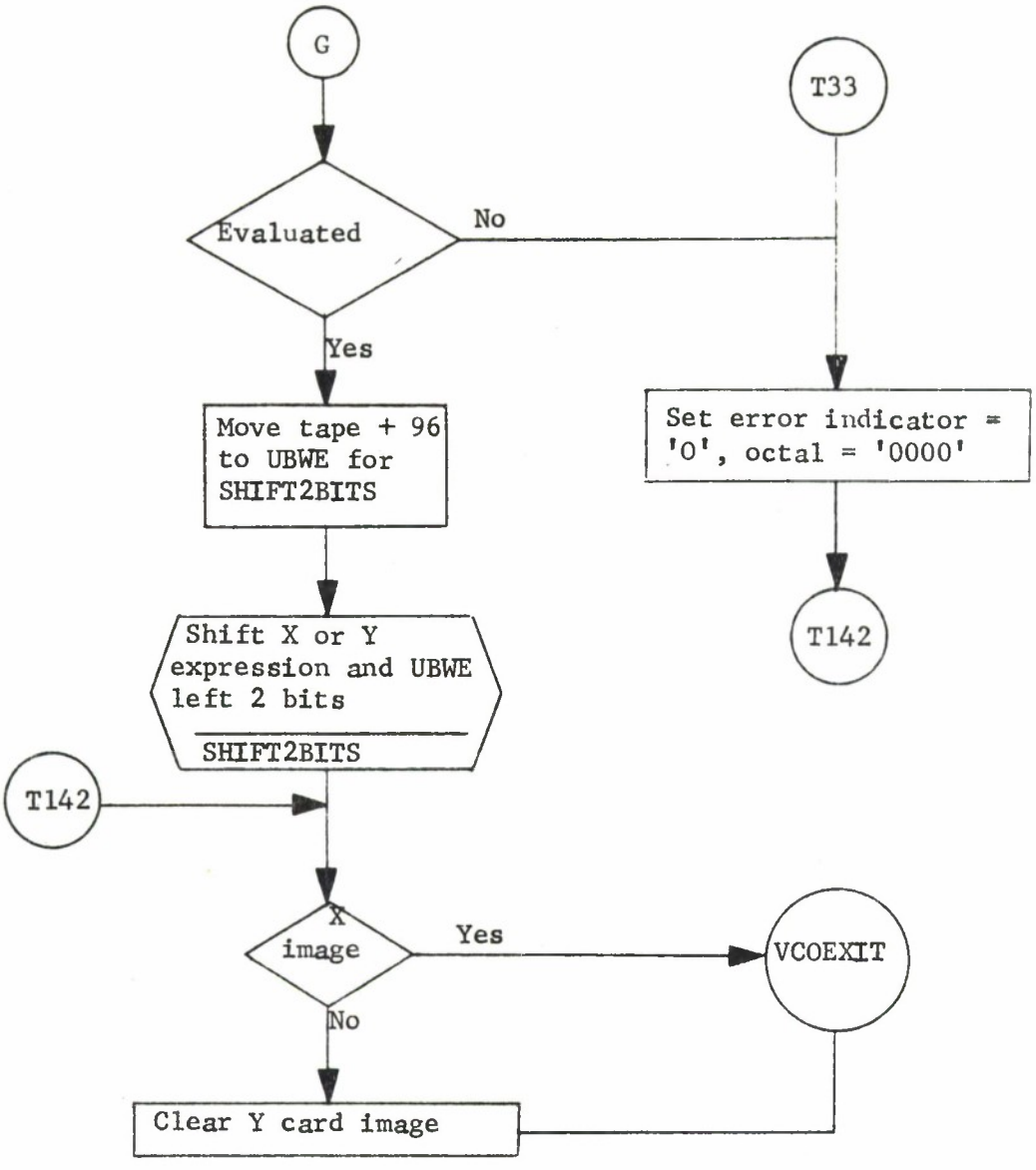

T1459
OP = VCO
No
T9555
Yes
T145
T7774
Set X error indicator = '0'
T143
T149
Move X finished indicator, error indicator = '0', and octal = '0000' in X tape image
Write X image
Move location counter to tape image for Y
F

VCO
(6 of 9)


F
Up location counter by 1
ADD1TOLOC
T150
T151
Error = '0'
Yes
No
T143
Set X error indicator = '0', octal = '0000', and finished indicator
Set X unfinished indicator and octal = '0000' in tape image
Write X image
Reset error indicator = null for Y tape image
T1999

VCO
(7 of 9)


T157
'0' set
Yes
No
T9555
Set Y unfinished indicator
Set Y error indicator = '0', octal = '0000', and finished indicator
VCOEXIT
TR21
TVC02
X image
Yes
No
Scan X expression
Scan Y expression
Found X
No
T33
Yes
Found Y
No
T33
Yes
Evaluate expression
EXPEVAL
G


G
T33
Evaluated
No
Yes
Move tape + 96 to UBWE for SHIFT2BITS
Set error indicator = '0', octal = '0000'
T142
Shift X or Y expression and UBWE left 2 bits
SHIFT2BITS
T142
X image
Yes
VCOEXIT
No
Clear Y card image

VCO
(9 of 9)

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13. ABSTRACT

This document describes the features, user procedures, and program/coding specifications for the BR-90 Assembly Program (BRASS) which is operational on an IBM 1410 computer.

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Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
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